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Engineering
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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Main Line Electrification in Scandinavia.—No. I.

The British Steam Railway Locomotive from 1825 to 1924—No. 4.

Gas Engineering in 1924.

Measurement of Mechanical Vibrations.

The Motor Liner Aorangi—No. IV.

Water Supply in 1924.

The Evolution of the Steamship.

High Pressure Electric Cables.

The Status of Engineers.

PUBLIC NOTICES

FIRE SERVICE.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 10th February, 1925, for the INSTALLATION of additional FIRE SERVICE at the Post Office Stores Factory, Birmingham.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender, &c., may be obtained from the Contracts Branch, H.M. OFFICE OF WORKS, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8133

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. DOG SPIKES.
2. STEEL FISH BOLTS and NUTS.
3. VACUUM BRAKE HOSE PIPES.
4. GLASS SHEET and PLATE, BULL'S EYE LENSES, and COTTON LAMP TAPE.
5. MISCELLANEOUS RAILWAY STORES, including Hinges, Measuring Tapes, Whiting, Borax, Prussiate of Potash, Bath Bricks, Lieuvain's Lubricators, Needles, Sieves, Soap, Linen Thread, &c.

Tenders due on the 30th January, 1925, for Nos. 1 and 2, on the 3rd February, 1925, for No. 3, and on the 6th February, 1925, for Nos. 4 and 5.
Tender forms obtainable from above. 8157

Chief Draughtsman and TECHNICAL INSTRUCTOR REQUIRED for the GOLD COAST GOVERNMENT RAILWAY, for two tours of 12 to 18 months' service each, with possible permanency. Salary £480 for the first three years, then £510, by annual increments of £30, to £720, and thence by £40 to £920. Outfit allowance of £60 on first appointment. Free quarters and first-class passages and liberal leave on full salary. Candidates, aged 25 to 35, must have served an apprenticeship or pupilage with a locomotive manufacturing firm or in home railway workshops, and have had subsequent experience in a locomotive drawing office. Preference will be given to candidates who, in addition, are Associate Members of the Institution of Mechanical Engineers or possess a diploma or degree in mechanical engineering.—Apply at once by letter, stating age and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/12,287. 8117

Royal Scottish Museum, EDINBURGH.
TECHNOLOGICAL DEPARTMENT.
The Scottish Education Department are prepared to NOMINATE CANDIDATES for the POST of ASSISTANT in the TECHNOLOGICAL DEPARTMENT of the Royal Scottish Museum. The normal salary on commencement is £250, rising, if service is approved, by annual increments of £20 to £450, and thence under certain conditions by annual increments of £25 to £700. A cost-of-living bonus on the scale applicable to the Civil Service is also payable at present. The post is a Civil Service one and is pensionable.

Candidates should be Graduates in Engineering or hold similar educational qualifications, and must be able to satisfy the Civil Service Commissioners that they have received such systematic education, general and technical, as in the Commissioners' opinion fits them for the post. Workshop experience is essential. The normal age limits are 26 to 30, but in special circumstances candidates under 26 or over 30 may be accepted. Further information regarding the method and conditions of appointment may be obtained from the Director of the Museum.

Applications for nomination, stating age and qualifications and accompanied by three recent testimonials, should be made in writing to the DIRECTOR before 14th February, 1925. Nominated candidates, after passing a written examination, if necessary, will be interviewed by a Selection Board. 8099

University College of South WALES AND MONMOUTHSHIRE.
COLEG PRIFATHROFAOL DEHEUDIR CYMRU A MYNWY.
THE ARCHIBALD DAWNAY SCHOLARSHIP.
This SCHOLARSHIP of £50 a year, tenable for three years by a student who intends to enter some branch of the Engineering Profession, will be OFFERED for COMPETITION at the College Entrance Scholarship Examination which begins on April 20th, 1925. Further particulars and a form of application can be obtained from the undersigned, to whom the form of application must be returned on or before March 24th, 1925.

D. J. A. BROWN, Registrar.
University College, Cardiff. 8113

Clifton Suspension Bridge COMPANY.
CLIFTON SUSPENSION BRIDGE.
The Clifton Suspension Bridge Company are prepared to receive TENDERS for the STRENGTHENING of the ANCHORAGES of the Leigh Woods side of Clifton Suspension Bridge. The work comprises the Fitting of Subsidiary Anchorage Steel Work and the Cutting Out of the adjacent Rock where necessary, &c.

Particulars and specification may be obtained either from the Secretary to the Company, John G. Bennehy, Esq., Albion Chambers, Bristol, or from the Consulting Engineers to the Company, Messrs. Howard Humphreys and Sons, 28, Victoria-street, Westminster, on and from Monday, January 26th, 1925, until Saturday, February 7th, 1925, between the hours of 10 a.m. and 4 p.m., upon payment of a deposit of Three Guineas, which deposit will be returned upon receipt of a bona fide Tender which is not subsequently withdrawn by the contractor.

The successful tenderer will be required to execute a contract deed, the draft of which may be seen at the offices and times aforementioned.

Tenders must be on the official form, each Tender in a sealed envelope, marked "Tender for the Strengthening of Clifton Suspension Bridge." Tenders must be accompanied by the general conditions and specification as issued by the Consulting Engineers. Each Tender must be signed in the handwriting of the tenderer or his authorised agent.

The Company does not bind itself to accept the lowest or any Tender.

Tenders must reach the undersigned by 9 a.m. on Monday, February 23rd.

JOHN D. DENNEHY,
Secretary to the Clifton Suspension Bridge Co.
8123

PUBLIC NOTICES

Loughborough College, LOUGHBOROUGH, LEICESTERSHIRE.
Dr. H. SCHOFIELD, M.B.E., Principal.
DEPARTMENT OF AUTOMOBILE ENGINEERING.
APPLICATIONS are INVITED for the POSITION of HEAD of the AUTOMOBILE ENGINEERING DEPARTMENT. Candidates should be Graduates of a British University, and have had practical experience in the Design and Manufacture of Automobiles. The scale of salary ranges from £450 to £650 by annual increments of £25, and the commencing salary will depend upon the qualifications and experience of the applicant.

All applications, with copies of not more than three recent testimonials, should be forwarded before January 28th to the REGISTRAR, from whom any further particulars may be obtained. 8070

Basingstoke Corporation Electricity DEPARTMENT.
TENDERS are INVITED for the SUPPLY, DELIVERY and ERECTION of :—
ONE 600 B.H.P. VERTICAL CYLINDER HEAVY OIL ENGINE and DIRECT-COUPLED DYNAMO.

Specifications, general conditions and form of Tender may be obtained on application to the undersigned on payment of a deposit of £2, which amount will be returned on receipt of a bona fide Tender.

Duplicate copies of specification, &c., may be had on payment of 5s. per copy, not returnable.

Sealed Tenders, marked "Tender for Generating Plant," and addressed to the Chairman of the Electricity Committee, must be delivered at the Electricity Works not later than Noon on Friday, January 30th, 1925.

The Council do not bind themselves to accept the lowest or any Tender.

F. SWARBRICK, A.M.I.E.E., A.M.I. Mech. E.,
Borough Electrical Engineer.
Electricity Works, Basingstoke. 8033

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
ELECTRIFICATION OF BOMBAY SUBURBAN LINES.
The Directors are prepared to receive TENDERS for the SUPPLY and ERECTION in India of the following PLANT :—
(1) OVERHEAD EQUIPMENT of PERMANENT WAY and OVERHEAD TRANSMISSION and DISTRIBUTION LINES.

Fee for specification £2 per copy.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

Tenders must be submitted in duplicate and must be sealed and addressed to the undersigned, marked "Tender for Overhead Equipment, &c.," and delivered not later than Noon on Monday, 9th March, 1925.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Bombay, Baroda and Central India Railway Company.

The Directors do not bind themselves to accept the lowest or any Tender.

The Consulting Engineers, to whom application for any further technical information may be made, are Messrs. Mers and McLellan, 32, Victoria-street, Westminster, S.W. 1.

S. G. S. YOUNG,
Secretary.
Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
19th January, 1925. 8134

PUBLIC NOTICES

Kent Education Committee.
ERITH TECHNICAL INSTITUTE.
REQUIRED IMMEDIATELY, a TEACHER of GAS SUPPLY, for 3 evenings per week. The classes are attended by local apprentices. Salary in accordance with the scale of the Kent Education Committee.

Send particulars of qualifications and experience to the PRINCIPAL, Technical Institute, Erith-road, Belvedere, Kent.

E. SALTER DAVIES,
Director of Education.
19th January, 1925. 8136

Metropolitan Water Board.
TENDERS FOR THE SUPPLY OF STORES, &c.
The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES, &c., for the periods of six or twelve months, commencing 1st April, 1925, as the Board may decide :—
Tender No.

1. Bricks, Fire-bricks, Cement, &c.
2. Brushes, Brooms and Handles.
3. Cast Iron Pipes and Irregular Castings.
5. Cotton Waste, Engine Wipers and Mutton Cloths.
6. Hemp, Yarn, Rope, House Flannel, Mats, &c.
7. Hire of Horses, Carts and Petrol Lorries and Supply of Sand and Ballast.
8. Iron and Steel.
9. Bolts and Nuts, Screws, Files, Tubes, Shovels and Picks.
10. Lead, Brass, Copper, Zinc and Glass.
11. Repair of Meters (Siemens).
12. Fuel Oil, Oils (Lubricating), Kerosene, Motor Spirit, Greases, Tallow, &c.
13. Oilman's Sundries, Soap, Tar, Gas Mantles, Metal Polish.
14. Packings, Rubber Goods, &c.
15. Paints, Varnishes, Linseed Oil, Turpentine, &c.
17. Pipe Laying Repairs, Alterations, &c.
18. Scrap Iron, Purchase and Removal of.
19. Small Iron, Brass, Gun-metal and other Castings.
20. G.M. Stopcocks and Ferrules.
21. Sluice Valves and Spindles, Hydrants, G.M. Outlets and Cans.
22. Timber, Hard and Soft Woods.
23. Maintenance of Weighing Machines.
24. Electric Lamps.
26. Furnace Refuse, Disposal of.

Tenders must be made on the official forms, which may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, on and after Thursday, 22nd January, 1925, by personal application (Room 156) or upon forwarding a stamped addressed brief envelope.

Applicants should refer to the number of the Tenders for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, Clerkenwell, E.C. 1," and endorsed "Tender for ——," must be delivered at the offices of the Board (Room 132) not later than 11 a.m. on Wednesday, 11th February, 1925.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board :
New River Head,
173, Rosebery Avenue, Clerkenwell, E.C. 1.
15th January, 1925. 8132

The County of London Electric SUPPLY COMPANY, LIMITED.
TURBINE ENGINE DRIVERS.
APPLICATIONS are INVITED for above. Experience in handling large high-speed turbo-generator units, preferably of the Parsons type, essential. Eight-hour shifts.—Applications to the RESIDENT ENGINEER, Barking Power Station, Creekmouth, Barking. 8150

PUBLIC NOTICES

Merthyr Tydfil Union.
HEATING, DOMESTIC HOT WATER AND LAUNDRY INSTALLATION.
TENDERS are INVITED by the Guardians of the Merthyr Tydfil Union for NEW HEATING and DOMESTIC HOT WATER SUPPLY INSTALLATION, together with ADDITIONS and ALTERATIONS to LAUNDRY PLANT, NEW STEAM MAINS, &c., for the Workhouse, Merthyr Tydfil.

The contractors will be required to pay their workmen not less than the standard rate of wages and conform to the recognised rules and regulations in the district.

Specification, conditions of contract and drawings may be inspected at the Union Offices of the above Guardians, 44, Thomas-street, Merthyr Tydfil, and copies of same, with form of Tender, will be forwarded on application, accompanied by a deposit of £4 4s. (Four Guineas), which will be refunded on receipt of a bona fide Tender.

The site can be inspected by contractors by appointment with the Master any weekday during normal working hours, on production of copy of specification, at the Workhouse Lodge. Any further particulars can be obtained from the Consulting Engineer, Mr. Herbert Brown, 2, Park-grove, Cardiff, by appointment.

Sealed Tenders, endorsed "Heating and Laundry Installation," and addressed to the undersigned to be delivered not later than Noon of the 21st February, 1925.

FRANK T. JAMES,
Clerk to the Guardians.
Union Offices :
44, Thomas-street, Merthyr Tydfil, Glam.,
17th January, 1925. 8112

Tees Valley Water Board.
NUNTHORPE SUPPLY, 1925.
CONTRACT NO. 3.
PUMPING MACHINERY.
TO CONTRACTORS.
The Tees Valley Water Board are prepared to receive TENDERS from competent persons willing to enter into a contract for the SUPPLY of PUMPING MACHINERY and ERECTION thereof at their Pumping Station in Normanby-road, South Bank, near Middlesbrough.

The drawings may be seen and copies of the specifications and bills of particulars obtained at the office of the undersigned, Municipal Buildings, Middlesbrough, and of the Engineers, Messrs. James Mansergh and Sons, 5, Victoria street, Westminster, London, S.W. 1, on and after Tuesday, the 20th instant, on deposit of £2, which will be returned after the receipt of a bona fide Tender, with the bills of particulars fully priced out. Early application for particulars is desirable, as only a limited number will be given out.

Sealed Tenders, endorsed "Pumping Machinery," are to be delivered at my office at or before Noon on Thursday, the 5th day of February, 1925.

The Board do not bind themselves to accept the lowest or any Tender.

(Signed) THOS. S. CLAVERT,
Clerk to the Board.
Water Board Offices, Middlesbrough,
16th January, 1925. 8104

County of London Electric SUPPLY COMPANY, LIMITED.
ELECTRICAL TESTING ENGINEER—BARKING POWER STATION.
APPLICATIONS are INVITED for above POSITION. Applicants must have previous experience in the manufacture and operation of instruments and accessories in connection with standard types of protective gear, and preference will be given to one having held a similar position with a supply undertaking. The engineer appointed will be responsible for the supervision and maintenance of the protective gear on a large system and generally to take charge of the department. Salary required, which will depend on experience, to be stated, together with particulars of age, experience and copies of testimonials and when at liberty, to be posted to the MANAGER and SECRETARY, County of London Electric Supply Co., Ltd., Moorgate-court, Moorgate, London, E.C. 2. 8149

The South Metropolitan Gas COMPANY has a VACANCY for an ENGINEER with wide experience in the design, construction, erection and repair of Gasholders, Retorts, and other Manufacturing Plant and Structures of the kind used in Gasworks and Coke Oven Recovery.

Applications, giving age, full particulars of qualifications, experience, military service, and salary required, should be made in writing to the undersigned before 7th February, 1925.

By Order,
FRANK DAY,
Secretary.
709, Old Kent-road, London, S.E. 15,
22nd January, 1925. 8151

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.
SITUATIONS WANTED, Page 2.
PATENTS, Page 3.
MISCELLANEOUS, Page 2.
PARTNERSHIPS, Page 2.
AGENCIES, Page 2.
FOR SALE, Pages 3, 4 and 93.
AUCTIONS, Pages 3 and 90.
BUSINESSES and PREMISES (For Sale, etc.), Page 3.
WORK WANTED, Page 4.

For Advertisement Rates see Page 107, Col. 1.

INDEX TO ADVERTISEMENTS, Page 89.

PUBLIC NOTICES

Egyptian State Railways, Telegraphs and Telephones.

"THE EGYPTIAN RAILWAY ADVERTISER."

A weekly publication in Arabic, English and French.

Subscription: 50 Egyptian Piastres (about 10 shillings) yearly.

An organ of the Egyptian State Railways, Telegraphs and Telephones, containing information of interest to Contractors and Suppliers of Materials and Stores used by the Administration.

For particulars apply to PUBLICITY SECTION, Egyptian State Railways, Cairo (Egypt). 8085

SITUATIONS OPEN

WANTED for Large Chemical Works in the Midlands, ASSISTANT POWER ENGINEER, with technical knowledge and practical experience of E.H.T. and L.T. Power Supply, Economical Steam Production, Hydraulics, Refrigeration, &c.—Address full particulars of experience, age, and salary required, 8138, The Engineer Office. 8138 A

ARTICLED PUPIL.—A CHARTERED CIVIL ENGINEER has VACANCY for well-educated Youth as ARTICLED PUPIL; good practical and theoretical training. Interesting works in progress. Premium.—Address, 8061, The Engineer Office. 8061 A

ENGINEER, Accustomed to Preparing Tenders for Turbine Plant and Power Station Equipment.—Address application, stating age, training, experience, and salary required, 8122, The Engineer Office. 8122 A

ENGINEER REPRESENTATIVE.—Well-known SUGAR MACHINERY MANUFACTURERS REQUIRE a REPRESENTATIVE (unmarried) for India. Must have had experience of making or designing, running and selling Sugar Machinery. Indian experience preferred, but not essential. Send full particulars of qualifications and experience.—Address, 8158, The Engineer Office. 8158 A

ESTIMATOR REQUIRED, Capable of Making Estimates from project drawings for Mechanical Handling Plants for coal and other materials. Only men with good experience and proved abilities need apply. State age, experience, and salary required.—Address, 8165, The Engineer Office. 8165 A

FOUNDRY MANAGER REQUIRED for Iron and Steel Foundry; must have had a thorough practical training and be a good disciplinarian, up-to-date knowledge of Moulding Machines and expert experience on Cupola Practice and Mixing by Analysis. A knowledge of Semi-steel, also Electric Steel Furnaces desirable.—Address in confidence, stating experience, references, and wages required, 8071, The Engineer Office. 8071 A

FOUNDRY MANAGER WANTED by Large Engineering Firm in the East Midlands. Must be first-class man, experienced in repetition production of soft iron castings, malleable castings, brass, and small quantity of steel castings. Must be energetic, good organiser, capable of controlling men and methods for good quality production.—Address, stating age, experience, and salary required, 8128, The Engineer Office. 8128 A

LONDON FIRM of REFRIGERATING ENGINEERS have VACANCY for capable MAN, about 30, assist in works management; capable draughtsman, well up in modern enclosed compressor design.—Address, 8152, The Engineer Office. 8152 A

SALESMEN REQUIRED for Engineering Speciality, with technical knowledge preferred. Commission basis and small drawing account.—Address, P140, The Engineer Office. P140 A

WANTED, an Experienced JUNIOR DRAUGHTSMAN, used to General Engineering Work; knowledge of Internal Combustion Engines a recommendation.—Address age, experience, and salary, 8139, The Engineer Office. 8139 A

WANTED, DRAUGHTSMAN, One who has had Previous experience on Constructional and Mechanical Work in connection with the Lay-out of Generating Stations and Sub-stations.—Address application, stating full particulars, training, past work and experience, age, commencing salary expected, date when at liberty, together with copies of recent testimonials, to 8043, The Engineer Office. 8043 A

WANTED, First-class MECHANICAL DRAUGHTSMAN, with good knowledge of Aeroplane Construction. Also well-trained JUNIOR for Aeroplane Drawing-office.—Apply, WESTLAND AIRCRAFT WORKS, Yeovil. 8111 A

WANTED, MECHANICAL DRAUGHTSMAN, with general works experience and knowledge of Lay-out of Steam Plant and Ventilating and Cooling Installations.

Applicants should state salary required and give particulars of their age and military service and forward testimonials and other records of their past experience in the class of work required.—Write, "B. D.," c/o Charles Barker and Sons, Ltd., 31, Budge-row, E.C. 4. 8130 A

DESIGNING DRAUGHTSMAN REQUIRED in connection with Coal and Mechanical Handling Plants. Only men with complete knowledge and first-class experience need apply. State age, experience, and salary required.—Address, 8166, The Engineer Office. 8166 A

DRAUGHTSMEN and ASSISTANT ENGINEERS REQUIRED in London for Structural Steel and Reinforced Concrete. State age, technical education, experience, salary required.—Address, P146, The Engineer Office. P146 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 98, St. George's-square, London, S.W. 1. 7871 A

DRAUGHTSMAN, Capable, Young, Quick, for Estimating Dept. Electric Lift experience preferable.—E. A. EVANS, Ltd., Prospect-road, Leicester. P145 A

DRAUGHTSMEN DESIGNERS and DETAILERS REQUIRED for Structural Steel Work.—Apply, giving full particulars, to BIRCHGROVE STRUCTURAL WORKS, Swansea. 8119 A

DRAUGHTSMAN, Experienced in Designing and detailing Steel and Timber-framed Building, &c. State age, experience, and salary required.—Write, Box D743, *Lee* and Nightingale, Advt. Offices, Liverpool. P161 A

DRAUGHTSMAN REQUIRED; Must be Sound in the design of Mechanical Details; electrical knowledge an advantage, but not essential. London, West. State age, experience, and salary required.—Address, 8162, The Engineer Office. 8162 A

DRAUGHTSMAN WANTED, First-class Man, Used to Mechanical Design, experience in High-class Switchgear preferable, but not essential. State salary.—Address, P132, The Engineer Office. P132 A

Important Manufacturers of first-class quality

BALL BEARINGS

are Open to Engage Firm of good standing and with good trade connection for the Sale of their Speciality in Great Britain.

Address, with full particulars, 8053, The Engineer Office.

SITUATIONS OPEN (continued)

DRAUGHTSMAN. — First-class MECHANICAL DRAUGHTSMAN WANTED by firm in N.W. London. Only men with sound technical training and thorough practical experience will be considered. Good position for right man.—Address, stating age, experience, and salary required, 8164, The Engineer Office. 8164 A

DRAUGHTSMAN REQUIRED, with Good Experience of Design of Semi-Diesel and Cold Starting Oil Engines.—Address, stating age, salary, and full particulars, 8114, The Engineer Office. 8114 A

DRAUGHTSMAN WANTED for Design of Steam Engines and Pumping Machinery. Must have up-to-date experience in this class of work. For right man this is a good opening. State age, experience, and salary required.—Address, 8159, The Engineer Office. 8159 A

INDIA.—REQUIRED by a British Firm of Bridge and Structural Engineers, a DRAUGHTSMAN, capable of preparing designs and estimates and experienced in the preparation of working drawings for Bridge and Structural Steel Work. Must be a bachelor, age 24 to 28.—Apply, stating age and giving full particulars of previous experience, to "Z. Z. 650," c/o Deacon's Advt. Agency, Londenhall-street, London, E.C. 3. 8145 A

REQUIRED, CHIEF DRAUGHTSMAN for Old-established General Engineering Firm within 30 miles of Nottingham. Must have a thoroughly practical knowledge of general engineering and be capable of controlling drawing-office staff. Applicants must give age, salary required, and full particulars of previous experience. All replies treated with strict confidence.—Address, 8167, The Engineer Office. 8167 A

REQUIRED for Important Argentine Railway, TWO ARCHITECTURAL DRAUGHTSMEN. Must be neat draughtsmen, able to prepare working drawings. If possible, have had railway experience in design of Goods Warehouses, Engine Sheds, and Local Passenger Stations. Age 24-32. Three years' contract at £400, £450, £500 p.a. for 1st, 2nd, and 3rd years respectively, with free passage out and home. Write, stating age and giving full particulars of education, training and experience, with copies (only) of testimonials.—Write, Box B. F. E., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 8163 A

REQUIRED by Large Engineering Firm in Midlands, a LEADING ENGINEER DRAUGHTSMAN for Internal Combustion Engines for industrial and marine purposes. Good scope for suitable man, who must also have some knowledge of Steam Engines.—Address, giving age, qualifications, and references, state when at libery, and what salary required, 8126, The Engineer Office. 8126 A

REQUIRED by London Firm, DRAUGHTSMAN, experienced in design of all kinds of Steel Works Furnaces and Gas Producers.—Address, stating age, experience, and salary required, 8124, The Engineer Office. 8124 A

REQUIRED for Important Argentine Railway, TWO ENGINEER DRAUGHTSMEN, with knowledge of the design of Bridge Abutments, Retaining Walls, Arches, Foundations and Drainage. Railway experience desirable. Age 24 to 32, single; 3 years' contract at £400, £450, and £500 p.a. for 1st, 2nd, and 3rd years respectively; free passage out and home. Write, giving full particulars of education, training, and experience, age, with copies (only) of testimonials.—Write, Box C. L. D., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 8148 A

WANTED, WHEEL SHOP FOREMAN, to Take Charge of Machining, Fettling and Finishing Railway Wheels. Must be good disciplinarian, used to fixing piecework rates, and thoroughly experienced with this class of work.—Address, giving past experience and wages, 8156, The Engineer Office. 8156 A

WANTED, First-class LOCO. FITTER, Able to be responsible for the complete overhaul of Locomotives, a thoroughly reliable man used to the latest practice; good wages. State age and experience.—Apply, MANAGER, Tredomen Works, Ystrad Mynach, near Cardiff. 8120 A

SITUATIONS WANTED

A.M.I.C.E. (34), Works and D.O., Locomotive, steam, I.C.E., general and constructional experience, good organiser, used to control of large staffs, some commercial experience, DESIRES POST as Technical Assistant, Assistant Manager, or other progressive position. Moderate salary.—Address, P123, The Engineer Office. P123 B

DISENGAGED.—MECHANICAL ENGINEER (23) DESIRES IMMEDIATELY POST where experience can be obtained.—POTTER, 25, Jevington-gardens, Eastbourne. P152 B

ENGINEER, Age 22, Excellent Exp. in Genl. and pneumatic eng., SEEKS POST as ASSISTANT ENGINEER or in drawing-office; 8 years shop, including indenture, and four years Polytechnic.—Address, P138, The Engineer Office. P138 B

ENGINEER, AGENT, REPRESENTATIVE DESIRES POSITION at home or abroad. Constructions, executive, commercial; speaks Spanish and Portuguese.—Address, P133, The Engineer Office P133 B

ENGINEER (35), A.M. Inst. C.E., SEEKS POSITION of permanent character in good firm. Experience in managerial duties, accountancy, D.O., marine, steam, motor, and semi-Diesel machinery, tank work, light structural steel, general engineering practice and the design and construction of small steel craft. Knowledge of French; available in May.—Address, P9951, The Engineer Office. P9951 B

ENGINEER—PRODUCTION (33), Chief Tool, D.O., planning, shop experience, used to responsibility on high-class manufactures, modern methods; London or district preferred.—Address, P9985, The Engineer Office. P9985 B

ENGINEER (24), Workshop, Technical and Commercial training, experienced design, lay-out, erection complete industrial plants, SEEKS POST, D.O., erection, buying, &c.—Address, P151, The Engineer Office. P151 B

SITUATIONS WANTED (continued)

ENTERPRISING SPECIALITY SALESMAN SEEKS CHANGE. Travelled London, Lancashire, North and South Wales, also Midlands. Desirous to represent high-class firm on salary and commission basis. Age 27.—Address, P141, The Engineer Office. P141 B

INSPECTION.

INSPECTING ENGINEER, A.M.I. Mech. E., Fully qualified, residing Stoke-on-Trent, UNDERTAKES INSPECTION of Locomotives, Railway Plant, Machinery, and Materials in Midlands. Terms and further particulars.—Address, P150, The Engineer Office. P150 B

IRON, STEEL AND ENGINEERING SALESMAN.—Mr. J. PILKINGTON HUNT, having completed six years' engagement with Messrs. Hall and Pickles, Ltd., is now OPEN to DISCUSS the REPRESENTATION of a high-class FIRM in the Manchester and Lancashire area.—Confidential communications to be addressed c.o. The Engineers' Club, Manchester. 8107 B

PLANT ENGINEER, M.J. Inst. E. (38), with 14 years' experience in charge of large steam and I.C. plants, both manufacturing and municipal, DESIRES responsible POSITION in any part of the country. Wide experience in the management of various industrial (brewing, laundry and dye works, &c.) and pumping plants. Used to labour control.—Address, W. H. T., 4, Chancelot-road, Abbey Wood, S.E. 2. 8115 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

New Cruisers for Foreign Service.

IMPORTANT changes in the composition of our naval forces on the foreign stations will take place this year. The cruiser Vindictive, which has been undergoing a lengthy refit at Chatham, will soon leave for the China Station, where she is to replace the Diomede. Built as the Cavendish, a cruiser of the 9750-ton "Raleigh" class, the Vindictive was subsequently converted into an aircraft carrier and renamed after the gallant old ship of Zeebrugge and Ostend fame. She has now been restored to her original design, save that a large aeroplane platform replaces the second bow gun, thus reducing the armament to six 7.5in. guns. Owing to her size, powerful battery, and speed of 30 knots, she will be a useful addition to the China Squadron, of which a sister ship, the Hawkins, is flagship. Furthermore, the East Indies Squadron is to be completely reorganised, and will in due course consist of the Effingham—another unit of the "Raleigh" class—as flagship, the Emerald and the Enterprise. According to present plans, the Effingham is to be completed in May, the Emerald in July, and the Enterprise in December, so that it will be at least twelve months before the last of the older ships now serving on the station is relieved. The new East Indies Squadron will be an exceptionally fast one, for the Effingham is designed for 31 knots and her two smaller consorts for 33 knots. With its headquarters at Trincomali, this force will be only some 1650 miles distant from Singapore, the southern base of the China Squadron. While it is too early to discuss the allocation of the new battleships and cruisers now being built, the dispositions named above suggest that the bulk of this material will, upon completion, be detailed for service on the Mediterranean and other foreign stations, in conformity with the strategical situation resulting from the war.

Motor Manufacturers and Wembley.

THE Society of Motor Manufacturers and Traders has now clearly defined its attitude towards participating in this year's Exhibition at Wembley. It seems that last autumn it informed the Exhibition authorities that the motor industry was not in favour of a reopening and that it was unlikely to support the Exhibition in its second year. Before the final decision to reopen was taken the Society informed the authorities that it could not co-operate and that its executive committee had decided to dissuade the members from participating. It is understood that the members of the Society have been advised that they may choose between Wembley and the Society's annual exhibition at Olympia. They will not be allowed to exhibit at both, but they may select Wembley without prejudicing their membership of the Society. This attitude, it is explained, is the same as that adopted by the Society in connection with the British Industries Fairs organised by the Department of Overseas Trade. It is strongly denied that the Society has been influenced in any way by any of its members having foreign interests.

Engineers' Wages.

LAST Friday, in London, the Engineering Employers' Federation met a hundred representatives of the thirty-seven unions having members engaged in the engineering industry for the purpose of giving further consideration to the men's claim for a general wages advance of 20s. per week. In the course of the conference, which lasted two and a-half hours, arguments supporting the claim were submitted by Mr. J. T. Brownlie and others of the men's leaders. After the employers had consulted in private, Sir Allan Smith on their behalf announced that the men's arguments would be given serious consideration and that another joint conference would be arranged at the beginning of February to deal further with the matter.

Thames Bridges.

IN the eighteenth century six new bridges were built across the Thames in the London area. Nine were added in the nineteenth century, but so far the twentieth century has witnessed merely the reconstruction of existing bridges. With the exclusion of the Tower and Wandsworth bridges and two iron suspension bridges at Battersea, London is served by exactly the same number of bridges as it possessed in 1831. Many schemes for new bridges are, of course, being actively discussed, but possibly because of the number of authorities interested in the subject there is still no sign of a decision being come to. On Monday the Bridges Committee of the London County Council received a deputation representative of the Royal Institute of British Architects and three other bodies. The deputation had many suggestions to offer. It was opposed to the proposed St. Paul's Bridge, but favoured the construction of a road bridge at Charing Cross with an approach that would avoid the Embankment and the Strand. It approved the Purfleet-Dartford tunnel below the Thames, recommended by the London Traffic Committee, and redirected attention to a scheme suggested a year or so ago for the construction of a double-deck bridge at a point near Temple Station. Its most ambitious and most novel proposal was for the building of a high-level bridge two miles in length from Woolwich to Beckton. This bridge, it was suggested, should start at Woolwich Common, pass over the town, cross the river, and the Albert Docks, and reach ground level at a point on the new Barking by-pass road. All these schemes involve work of considerable engineering interest, but some of them have obviously been prepared by architectural and town-planning enthusiasts and not by engineers. As regards Waterloo Bridge, we note that the Council of the Institution of Civil Engineers has supported the advice of the two consulting engineers, who have reported unfavourably on the proposal of the Society for the Protection of Ancient Buildings that the bridge should be preserved in its existing form by underpinning it.

Concrete Houses.

THE report which has just been presented to the Minister of Health by the Committee appointed to investigate new methods and materials for house building suggests that there may be considerable scope for engineering manufacturers in this direction, over and above the production of steel houses. The report deals with concrete as a structural material, and the Committee expresses the opinion that pouring *in situ* is the best method of utilising it. In this connection it is suggested that steel shuttering might be used. One of the great advantages of concrete, it is pointed out, is the fact that five-sixths of the materials required can generally be found locally. It is stated definitely that concrete houses can be so built that they are comfortable, dry, healthy, and satisfactory in appearance. The outer layer of the walls should, it is said, be made impervious, while the inner layer should be of porous ingredients in order to prevent capillary attraction and the passage of heat. In support of these suggestions it is pointed out that concrete floors, with linoleum or cork carpet laid upon them, have been in use in office blocks, with hard wear, for upwards of twenty years. Reference is made to the use of pre-cast concrete blocks, to the cement "gun" for plastering purposes, and to the importance of attending to the quality of materials and their manipulation.

Two Clydebank Liners.

LAST week was notable in the annals of the Clydebank shipyard of John Brown and Co., Limited, for it marked the completion of two large liners, constructed for the Orient Steam Navigation Company and the Canadian Pacific Railway Company. On Wednesday, the 14th inst., despite heavy weather on the Firth of Clyde, some short sea trials of the twin-screw liner Oronsay were made. The Oronsay is the latest addition to the Orient fleet. She has a length of 636ft. and a gross tonnage of 19,800. She is the largest liner which has been built on the Clyde since the Cunard liner Franconia was completed by the same builders nearly two years ago. Her propelling machinery is of the twin-screw Brown-Curtis single-reduction geared turbine type, designed for 20,000 shaft horse-power and a service speed of 18 knots. The Oronsay sails from London on her maiden voyage to Australia on February 7th. On Thursday, the 15th inst., the Countess Kathleen, the first of two twin-screw Canadian Pacific liners constructed by John Brown and Co., Limited, at Clydebank, left Greenock *en route* for Vancouver *vid* the Panama Canal. On reaching Vancouver the Countess Kathleen will take up her regular service on the company's triangular route between Vancouver, Victoria and Seattle. The Countess Kathleen is 368ft. long, and has a burthen of 6000 tons gross. She is propelled by Brown-Curtis single-reduction geared turbine machinery, designed for an output of 13,500 shaft horse-power, and her trial speed was 22½ knots. Her sister ship, Princess Marguerite, is approaching completion at Clydebank.

British Textile Machinery.

A SEVERE and sustained attack on British textile machinery was made by Mr. W. A. Hanton, of the Textiles Department, Manchester College of Technology, at a meeting of the Textile Institute in Manchester last Friday. Mr. Hanton spared no one in his criticism. The machinery manufacturers, the users, employers and workpeople alike, and even those responsible for the training of textile engineers, came under his lash, and, curiously enough, more than one machinery maker or user agreed with him. The machinery manufacturer, Mr. Hanton said, was often conservative, unwilling to change his patterns, slow to experiment and loth to adopt suggestions. He was often easily persuaded by customers to make alterations against his better judgment, and in essential matters failed to insist on having his own way. Many parts of the machinery showed a crudeness of design and bad, inaccurate workmanship. Of the machines, the loom was not the only one that was unnecessarily noisy, and the cause of an unnecessary amount of vibration. Fault could be found with most parts of the power loom, and the working of many parts of the self-acting mule was open to criticism. On the educational side, he urged that more should be done towards providing suitable courses for draughtsmen and mechanics, and that the textile engineering student should not, as at present, be compelled to devote a large part of his time to pure mechanical engineering. A greater amount of research work, increased co-operation between the colleges and the factories, and an augmented supply of text-books on textile machinery design were also urgently needed.

Power Alcohol from Beet Sugar.

IN a Journal note in our issue of December 12th last we referred to a deputation from the British Power Alcohol Association which waited upon the Minister of Agriculture to request that the proposed subsidy on beet grown for sugar should be extended to beet grown for the purpose of making power alcohol. Although sympathetic to the idea of rendering Britain less dependent on fuel obtained from foreign sources, the Minister is understood to have stated that in view of the preliminary character of the work done in connection with the production of power alcohol in this country, he could not feel justified in extending the scope of the proposed subsidy. In order to facilitate the introduction and permanent establishment of the industry, the Power Alcohol Association has now suggested to the Government that it should adopt one of two courses which would provide it with information which might indicate the desirability of a general subsidy. Either a committee of five experts should be set up to examine and report upon the methods used and the results obtained in European countries where power alcohol is being made, or a small factory should be started and run under subsidy for a period of three years.

Nitrogen Fixation.

IT is reported from Oslo that the German undertaking known as the Badische Anilin und Sodafabrik, already said to be the largest organisation in the world for the fixation of nitrogen, is again seeking to extend its business on the manufacturing side by securing the rights over 500,000 hydraulic horse-power in Norway. As there already exists a Norwegian company operating a fixation process, and as on a previous occasion the German engineers and officials whom the Badische Company sent to make investigations adopted a very intolerant attitude to the local inhabitants, the Norwegians are not viewing the German proposals with great favour. Elsewhere processes for the fixation of atmospheric nitrogen are being extensively developed. In Italy two developments of the Haber ammonia process have recently been brought to a forward stage. One of them, the Casale process, is about to be applied in France in a number of factories to be erected in the Lower Alps. These factories will have a daily output of 150 tons, and, it is intended, will begin operating this year. In addition, the same process is to be used at a factory to be erected for the French War Office, which will have a daily output of 120 tons, and which will be completed next year. The Casale process is also being used or is about to be used in Belgium, Holland, Spain, Switzerland, Norway and even Germany itself, principally in some small factories recently erected or in course of erection. The second Italian process, the Fauser, is at present in use only in one small experimental factory at Novara, but a 30-ton factory is being erected in the Italian Tyrol for operation this year, and a 10-ton factory is being established in Sardinia.

Oil Pollution in Coastal Waters.

AT the International Shipping Conference held in London in May last, a committee was appointed to consider, in its international aspect, the question of the pollution of coastal waters by oil discharged from ships. The work of this committee will be greatly facilitated by a sub-committee of British experts which was created by the Chamber of Shipping of the United Kingdom and the Liverpool Steamship Owners' Association to examine and report upon oil pollution as it may affect our home coasts. The committee has now received evidence from shipowners, port authorities and manufacturers of oil separators, and has further received assistance in its investigations from the Admiralty, the Board of Trade, and Lloyd's Committee. Its report, which was submitted, we understand, yesterday—Thursday—to the Council of the Chamber of Shipping, indicates that certain measures are contemplated, and, in fact, are already in hand, which should tend effectively to reduce the nuisance of oil pollution around our coasts.

Wages in the Electricity Industry.

THE West Midlands Industrial Council for the electricity supply industry has decided to restore to junior workers under twenty-one years of age the sum of 1s. 3d., which was taken off their wages in February, 1923. When the special reduction of 2s. 6d. per week in the wages of the adult workers was agreed to in January, 1923, it was also decided that in the case of youths between sixteen and twenty-one years of age there should be a reduction of 1s. 3d. per week. The 2s. 6d. per week having been restored to the adult workers from the beginning of December, it is considered equitable that the reduction in the case of junior workers should also be restored.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. IV.*

PERIOD 1830–1837 (*continued*).

Goods Engines, 0–4–2 *Type*.—Just as the 2–2–2 type was evolved from the 2–2–0, so the 0–4–2 type of goods engine was derived from the 0–4–0 by the addition of a pair of trailing wheels. The first two 0–4–2 engines were built by R. Stephenson and Co., for the Leicester and Swannington and the Stanhope and Tyne railways, the former being delivered in December, 1833. These engines, an example of which is shown in Fig. 18, were in great demand on many railways until about 1846. The coupled wheels

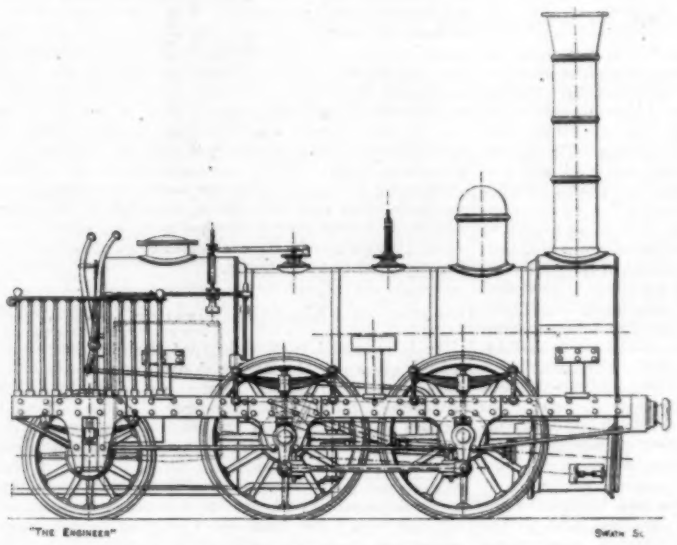


FIG. 18—STEPHENSON'S 0-4-2 ENGINE, 1833

were generally 4ft. 6in. diameter, though those on the North Midland and the Manchester and Leeds railways had 5ft. wheels, and there were one or two exceptional cases in which 5ft. 6in. wheels were used. The cylinders were 14in. by 18in. The weight in working order of the earlier engines was about 14 tons, but was increased to about 16½ tons in later designs.

Goods Engines, 0–6–0 *Type*.—The first 0–6–0 engine with inside cylinders was built by R. Stephenson and Co. in February, 1834, for the Leicester and Swannington Railway, and showed a remarkable advance in dimensions, the cylinders being 16in. by 20in., and the coupled wheels 4ft. 6in. The total heating surface, which in the previous 0–4–2 type was 504 square feet, was increased to 656½ square feet, of which the fire-box supplied 67.45 square feet. The boiler pressure does not appear to be known, but nearly all engines of that period worked at 50 lb. per square inch.[1] The wheel base was 11ft. 7½in. As in the engines previously described, from which this new type was derived, the main framing was outside and of the sandwich type, with additional inside bearings for the driving axle. The fire-box casing was flush with the barrel, and the boiler was 3ft. 11in. in diameter.

Bogie Locomotives.—The first bogie engines built in this country were exported in 1833 to the United States by R. Stephenson and Co. and Tayleur and Co. (now the Vulcan Foundry). The bogie was originally patented by William Chapman in 1812, and was applied to trucks at Newcastle. The eight-wheeled Wylam locomotives of about 1815 are stated to have had one swivelling truck, and the illustration in Wood's Treatise on Railroads certainly shows one of the trucks with a central pin, but the spur gearing in the illustration is such that had any swivelling movement taken place, the teeth of the wheels would have either locked or broken. A commission of three American engineers visited this country in 1828, and, according to Zerah Colburn, were recommended by R. Stephenson to use a bogie for their locomotives which were intended to negotiate curves of 400ft. radius. J. G. Warren, in "A Century of Locomotive Building," page 305, remarks that "we have no contemporary evidence of this statement." But there does not appear to be any reason for not accepting a statement made by Robert Stephenson himself to Colburn, and the latter, an American engineer, who was always careful in giving due credit to American inventions, throws no doubt upon it. It also appeared in *Engineering*, April 3rd, 1868, but the date of the visit of the American engineers is there given as "about 1830." The late Sir Charles Gregory also referred to it in a discussion on "Locomotive Engines for Sharp Curves" (Proc., Inst. C.E., 1863–4, Vol. 23, page 429). The first bogie locomotive in the U.S.A. was constructed by J. B. Jervis in 1832.

Fig. 19 shows one of two 4–2–0 engines built by Tayleur in March and April, 1833, for the Camden and Woodbury Railroad, though, as this line was not opened until 1838, they probably worked for some time on the Camden and Amboy Railroad. The cylinders, 9in. by 14in., were inclined and placed just inside the sandwich frames. The driving wheels, 4ft. 6in. diameter, were behind the fire-box and fixed on an inside cranked axle. The fire-box casing was sufficiently narrow to allow the long connecting-rods to pass between it and the frames. The boiler was only 2ft. 7in. in diameter. Total wheel base, 10ft. 3in. The valve gear is not clearly shown, but was actuated by a single excentric with a rocking shaft at the back of the driver's platform. The illustration shows one peculiarity in that there is apparently a pair of rollers between the main and bogie frames, and no pivot is shown. This must be an error in one of the old drawings. Messrs. R. Stephenson and Co. built a similar engine for the Saratoga and Schenectady Railroad, and the working drawing shows a pin. The outer crank cheeks of the crank axle were placed against the bosses of the driving wheels.[2]

In considering the general design of the Fire Fly, it is at once apparent that it includes the main feature of Crampton's subsequent well-known patent with the driving wheels behind the fire-box. Nevertheless, Crampton's design was independently conceived, and it was many years later before he heard of these 4–2–0 engines for America.

Hackworth's Engines with Vertical Cylinders.—The developments down to 1835 recorded above resulted in a type of locomotive which in all essential characteristics and in the majority of its details was similar to the locomotive of the present day. But this type was not at that time universally accepted as the most suitable, and it is necessary to return to the year 1831, and follow the other school of locomotive designers, of whom Timothy Hackworth was the principal and greatest exponent. Naturally, it was chiefly in the North-East of England, more especially on the Stockton and Darlington Railway, where Hackworth's engines were to be found. Their principal characteristics were the continued use of vertical and subsequently of steeply inclined cylinders, and of flue instead of multitubular boilers.

In 1830 Hackworth designed two classes of engine for working the coal traffic of the Stockton and Darlington Railway, in both of which the vertical cylinders and the six-coupled cast iron wheels of the "Royal George" type were retained, but the "motion" and boilers were different. The six engines of the No. 12 or "Majestic" class had the cylinders placed upon an overhanging platform in front of the smoke-box.[3] The piston-rods issued from the bottom ends of the cylinders and the connecting-rods, which were somewhat short, drove a dummy crank shaft with bearings in brackets fixed on extensions of the framing. The latter was inside the wheels, and appears to have been formed of a simple bar with pedestals bolted on, though different from that of Bury's engines. The dummy crank shaft was coupled to the first of the six coupled wheels. The boiler contained a flue, 9ft. long and 2ft. 6in. diameter, at one end of which the fire-grate was placed; the other end was separated from the boiler by a partition plate with a series of copper tubes, 4ft. long, through which the gases passed to the smoke-box.

In the other six engines of the "Wilberforce" type—Fig. 20—the vertical cylinders and "dummy" crank shaft were placed at the back end. The boilers were also different, and of the combined flue and return multitubular type, which appears to have been intended to combine the advantages of the multitubular boiler with Hackworth's favourite longitudinal flue. The main tube tapered from about 2ft. 4in. diameter at the fire-grate end to about 2ft. diameter at the back, where it entered a D-shaped combustion chamber. From this chamber the gases returned through a number of small copper tubes, fifty-two to seventy in number, to the fire-grate end, at which the chimney was placed on a semi-circular smoke-box. Sections of this type of boiler were given in THE ENGINEER of October 31st, 1879, page 322. It had the advantages that it was somewhat cheaper to construct than the ordinary multitubular type, and the whole of the flue, tubes and combustion chamber could easily be removed, and a duplicate set substituted instead of cutting out a fire-box with its many stays. On the other hand, the single flue restricted the size of the grate, which was placed inside it, so that boilers had to be unduly forced when the engines were heavily loaded. Though the

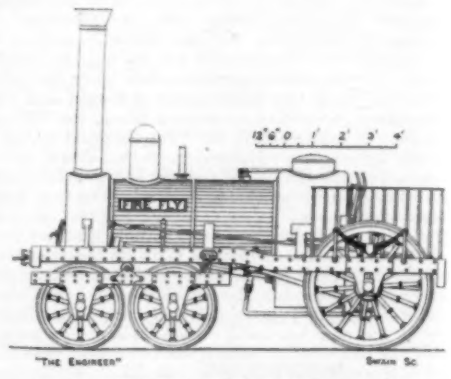


FIG. 19—TAYLEUR'S BOGIE LOCOMOTIVE, 1833

fuel consumption under these conditions was often heavy, the wear and tear of the boilers was light, and it is probable that Hackworth had this point and the necessity of keeping the engines in service in view, rather than fuel economy. It is fair to say that these boilers were stated to have given complete satisfaction on the Stockton and Darlington Railway.

All the above engines were put to work in 1831–3. The "Majestic" class had 13in. by 16in. cylinders, the "Wilberforce" class 14½in. to 14¾in. diameter by 16in. stroke. The cast iron wheels were 4ft. in diameter. The heating surface of the "Wilberforce" class was about 500 square feet, and the pressure 60 lb. For some time Timothy Hackworth clung to the vertical cylinder design, with dummy crank shafts, and built similar but slightly larger engines in 1835–8. The direct drive of the Royal George was abandoned, probably for the reason that the driving axle could not be provided satisfactorily with springs. It must be conceded that the vertical cylinders, dummy shaft with its coupling rod, and considerable overhang of the point at which the power was applied, did not form a good mechanical combination, and apparently a counter-

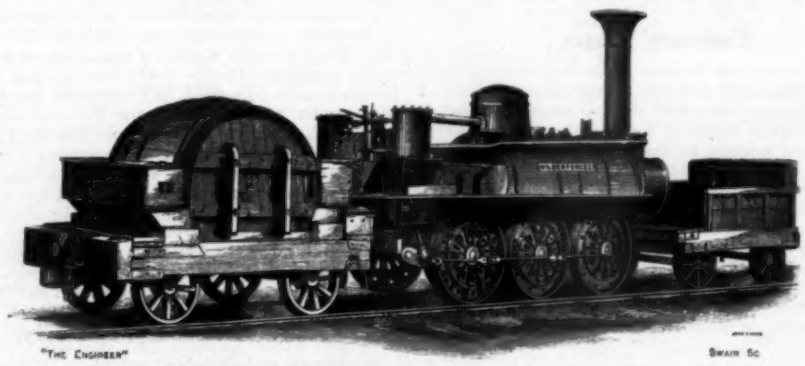


FIG. 20—STOCKTON AND DARLINGTON RAILWAY—"WILBERFORCE," 1831

weight was required at the other end of the engines. But the speed of coal trains on the Stockton and Darlington Railway was rigidly limited to 6 miles per hour, and this fact must be taken into account when criticising the design. In the Globe and other passenger engines, with one exception, to be mentioned later Hackworth employed horizontal cylinders.

In the case of the return flue and return multitubular boilers there was also the disadvantage of having to provide two tenders, one at each end.

Other Locomotives with Vertical Cylinders.—But there were other locomotive manufacturers who did not as yet see the advantages of horizontal or nearly horizontal cylinders. Messrs. Galloway, of Manchester, built an engine for the Liverpool and Manchester Railway in 1832 which had vertical cylinders, 12in. by 16in., and four coupled wheels 5ft. diameter. The cylinders were inverted and supported on pedestals carried by the outside frames near the middle of the engine, half-way between

* No. III. appeared January 16th.

the driving wheels. The piston-rods issued from the tops of the cylinders, and the connecting-rods drove a dummy cranked shaft of the form of a crank axle for an inside cylinder engine. This had bearings in the outside frames, with outside cranks for the coupling rods. The wheels were inside the frames, and their axles, unlike those of the E. B. Wilson dummy shaft engines of a later date, also had outside cranks.[4]

The locomotive by J. and C. Carmichael, of Dundee—Fig. 21—was one of those built for the Dundee and Newtyle Railway—4ft. 6in. gauge—of which the first two were put to work in September, 1833, and the third in March, 1834. The vertical cylinders, 11in. by 18in., were placed on the outside framing at the centre of the engine, and the piston-rods, which issued from the tops, were connected through bell-crank levers, as shown. The front or driving wheels were 5ft. in diameter, and the pressure 50 lb. per square inch. The trailing end was carried on a four-wheeled bogie with 3ft. wheels, and these were the first bogies to be fitted to railway locomotives for work in this country. The weight was about 9½ tons in working order, and the engines cost £700. One of these engines, The Earl of Airlie, was at work until 1850, after which it was used as a pumping engine. The late Mr. Alexander Allan had it put into order and photographed.

A vertical cylinder engine on similar principles with bell-crank lever was built by Sharp, Roberts and Co., for the Liverpool and Manchester Railway,

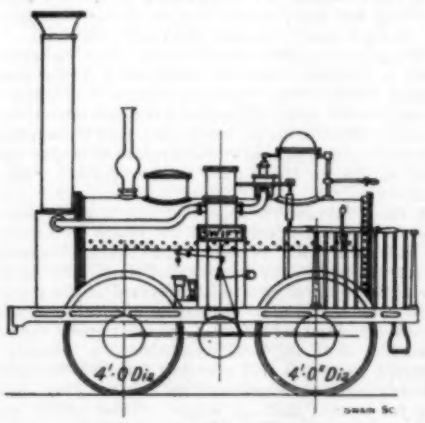


FIG. 23—HAWTHORN'S "SWIFT," 1836

in 1833. It was illustrated in THE ENGINEER August 24th, 1923, and need not be described again. The same firm, in 1834, built three engines for the Dublin and Kingstown Railway—see THE ENGINEER, March 22nd, 1883—in which the vertical cylinders, 11in. by 16in., instead of being situated near the middle of the engine below the platform, were placed just behind the smoke-box and above the leading wheels. A heavy triangular bell-crank was used to connect the piston and connecting-rods. The driving wheels were 5ft. in diameter.

On railways on which passenger trains at fair speeds had to be worked, all these engines proved failures owing to the pitching motion on the springs. The Dublin and Kingstown engines had to be converted to six-wheeled engines, but only slight improvement resulted. The Dundee and Newtyle engines lasted longer; the speeds were slow and the line short, and probably the worst effects of the pitching action were mitigated by the use of the four-wheeled bogie.

Another locomotive with vertical cylinders was the Swift—Fig. 23—built for the Stockton and Darlington Railway in 1836, by R. and W. Hawthorn. It was of the 0–4–0 type with 4ft. wheels. The cylinders were placed at the sides of the boiler, and had a direct drive on to an intermediate "dummy" crank shaft carried across the engine under the boiler. The wheel and shaft arrangement was similar in principle to that of Galloway's Liverpool and Manchester engine of 1832, but the latter had a considerably longer wheel base and inverted instead of direct drive from the cylinders. The Swift also differed in having inside frames and an outside platform, which helped to support the cylinders.

The cross section of the boiler was like the vertical section of a cottage loaf. It had a single flue straight through to the smoke-box. The valve motion is stated to have been of the gab type with two loose excentrics. A curious feature was that the weigh-bar shaft is stated to have passed right through the boiler, inside a transverse tube provided for the purpose. All the illustrations appear to show this. At a later date the engine was somewhat modified, when a revolving cowl formed the chimney top.[5] This cowl could be turned round to suit the direction of the wind. It does not appear to have been definitely stated that Timothy Hackworth designed this engine, but the vertical cylinders and dummy crank shaft seem to be strong evidence of his collaboration, since these features and the flue boiler were not those of Messrs. Hawthorn's usual design, and, moreover, he was entirely responsible for the locomotive power of the Stockton and Darlington Railway.

Forrester's Engines with Outside Horizontal Cylinders.—Other locomotive engineers proceeded on more orthodox lines. Amongst them was George Forrester, of Liverpool, who saw the advantage of horizontal cylinders, but wished to move the machinery from beneath the boiler, and make it more accessible. Forrester's standard engine—Fig. 22—was the first to have *outside* horizontal cylinders. Three of these engines were built for the Dublin and Kingstown Railway, one for the Liverpool and Manchester Railway, all in 1834, and others subsequently for the London and Greenwich Railway. With outside cylinders Forrester combined outside plate frames and bearings, an arrangement which, though at one time very common in South Germany and Austria, has not been adopted by British engineers, except for narrow gauge engines. In the case of Forrester's engines it was soon found that the wide spacing of the cylinders caused extreme swaying motion on the road, so much so that they earned the nickname of "boxers." In 1836 an additional trailing axle was placed behind the fire-box to steady them. The valve gear had four fixed excentrics, and these engines were the earliest to be so fitted. They actuated the valves by four separate gab-end excentric rods, two for forward and two for back gear. This arrangement removed the constant rocking movement of the starting handles near the driver's position, and allowed better facilities for shunting at stations. A sectional plan of one of these engines, by Alexander Allan, in which the valve gear is shown, appeared in THE ENGINEER of March 2nd, 1883. The first three engines of 1834 for the Dublin and Kingstown Railway had no slide bars, a form of swing link parallel motion being used, but the Liverpool and Manchester and subsequent engines had slide bars. The outside frames were of solid wrought iron plates, and the axle guards and frames were solid, and not bolted together. These engines had 5ft. driving wheels, and 11in. by 18in. cylinders.

Here it may be convenient to correct an error in D. K. Clark's "Locomotive Machinery," page 10, Fig. 11, which also appears in Colburn's work, page 41, Fig. 42. These illustrations show a Forrester six-wheeled engine, with slide bars outside the outside frames, and a different valve gear with vertical excentric rods. But they do not, as was stated, represent the 1834 design; the latter was the four-wheeled engine described above. The valve gear with vertical rods—D. K. Clark, Figs. 11 and 25—was applied in 1840 to two six-wheeled engines for the Grand Junction Railway, and it may have been used on four similar engines built in 1838 by the same firm for the Birmingham and Gloucester Railway. All these engines had some points in common with Clark's Fig. 11, but their driving wheels were 5ft. 6in. diameter. Alexander Allan, who was with Forrester until 1840, in a private letter in the possession of the writer, found fault with Clark's illustration for the reason that the cylinders of all Forrester's engines until that date were fixed between the outer and inner frames, as in Fig. 22, but not attached outside

FIG. 21—DUNDEE AND NEWTYLE RAILWAY ENGINE "EARL OF AIRLIE," 1833

FIG. 22—DUBLIN AND KINGSTOWN RAILWAY ENGINE "VAUXHALL," 1834

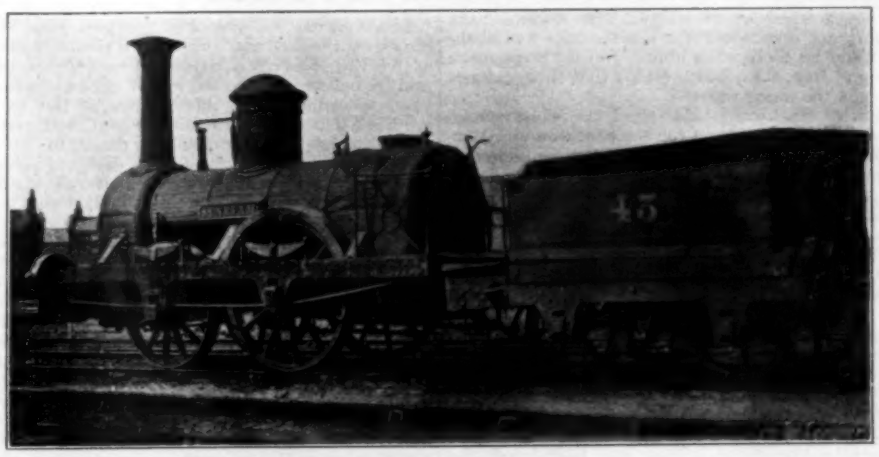


FIG. 24—STOCKTON AND DARLINGTON RAILWAY ENGINE "SUNBEAM," 1837

the outer frames, and that all had four and not two slide bars. Further, the trailing wheels, 3ft. diameter, of Forrester's engines were always smaller than the leading wheels, which had a diameter of 3ft. 6in. The cylinders of these later engines were 13in. by 18in. None of Forrester's outside framed engines, with outside cylinders, were built for this country after 1840.

The valve gear referred to above was actuated by one fixed excentric on each side, instead of the four excentrics used in the earlier engines. The excentric rods were shortened and the levers lengthened to obtain a greater angle of movement. Fuller particulars are given in D. K. Clark, page 21.

Hawthorn's Comet.—The use of four fixed excentrics was also adopted by R. and W. Hawthorn, independently of Forrester's design, in the 0–4–0 engine Comet, which started work in March, 1835, on the Newcastle and Carlisle Railway. This engine had inside cylinders and inside plate frames, with axle guards bolted on. The cylinders, 12in. by 16in., were inclined slightly upwards, and the piston-rods passed underneath the leading axle. The wheels had a diameter of 4ft. The Comet was an engine of what may be termed orthodox design, and was the forerunner of a considerable number of similar engines. It was illustrated in THE ENGINEER of July 14th, 1922, page 29.

Hawthorn's "Planet" Type Locomotives.—Considerable interest attaches to the Stockton and Darlington engine Sunbeam—Fig. 24—by R. and W. Hawthorn, 1837, in that although the design was on the lines of Stephenson's Planet, the engine was purchased by the railway of which Timothy Hackworth then had the contract for locomotive power. The driving wheels were 5ft. in diameter, and the cylinders 12in. by 18in. The leading wheels were 4ft. diameter. Weight in working order 9 tons 13 cwt., and empty 8 tons 11 cwt.

The Sunbeam does not appear to have been built for the Stockton and Darlington Railway, but was one of four engines intended for the New York, Boston and Providence Railway, U.S.A., of which only one appears to have been sent to America. The two others went to the Paris and Versailles Railway. Two smaller "Planet" type engines by Stephenson had been purchased previously in 1831 by the Stockton and Darlington Railway.

"Short Stroke" Locomotives.—In 1836 the locomotive department of the Liverpool and Manchester Railway considered that, in view of the increased speed of passenger trains, it might be desirable to reduce the piston velocity by shortening the stroke. Eleven passenger engines of the standard 2–2–2 type were built by Tayleur, R. and W. Hawthorn, and Mather, Dixon, with cylinders 14in. diameter by 12in. stroke, instead of the 12½in. by 16in. and 12in. by 18in. cylinders which were then generally used. There does not appear to be any record of the actual performances of these engines in their original condition. Edward Woods ("Observations on the Consumption of Fuel and the Evaporation of Water," in Tredgold's "Steam Engine") stated that their use coincided with an extravagant increase in coke consumption, but added that it was erroneously attributed to the mechanical disadvantage of the short stroke. The slide valves on the Liverpool and Manchester Railway at this time had no lap, and the steam was not worked expansively. The engines were certainly not a success; the short stroke was abandoned and no more were built. Robert Stephenson ("Proc.," Inst. C.E., 1849) stated that these engines consumed too much water.

Timothy Hackworth also tried the short stroke engine. The Arrow, built for the Stockton and Darlington Railway in 1837, at his works at Shildon, had 9in. piston stroke only. The late Joseph Tomlinson gave the diameter of the cylinders as 17in., but another, though probably incorrect, official record stated 21in. The Arrow had been preceded in 1836 by a locomotive built by Hackworth for Russia, also with 17in. diameter by 9in. stroke cylinders.[6] Both engines were of the 2–2–2 type with 5ft. driving wheels, outside frames and inside horizontal cylinders, following the lines of Stephenson's patent engine of 1833. They were also the first engines built at Shildon with multitubular boilers and inside fire-boxes of the ordinary type.

Instead of a short crank with a throw of only 4½in., one 9in. long was used. To produce the equivalent of a stroke 18in. long, a lever was introduced, the fulcrum of which was fixed to the bottom of the boiler. The piston-rod was attached to a point in the middle, and the small end of the connecting-rod to the bottom. Although J. Tomlinson ("Proc.," I. Mech. E., 1890) stated that this was not Hackworth's design, but a subsequent alteration, J. W. Hackworth not only ascribed it to his father, but added that the latter considered the arrangement likely to be used to a greater extent.[7]

Tomlinson further adds that the Arrow was provided with a cross shaft on which there were two solid cast iron friction wheels. By means of levers, the latter could be pulled down between the driving and trailing wheels, thus converting a "single" engine into the equivalent of a coupled engine. It is doubtful whether the Arrow, which was put to work in May, 1837, had this arrangement when new, for the patent was that of John Melling, locomotive superintendent, of the Liverpool and Manchester Railway, to whom it was granted in July, 1837. It is of interest to note that Mr. F. W. Webb applied a similar friction wheel coupling to a London and North-Western passenger engine[8] about sixty years later.

[1] It may be noted that in the early descriptions of engines by most authors, the boiler pressures were generally omitted. Even D. K. Clark's full descriptions are lacking in this respect.

[2] The design of both Stephenson's and Tayleur's engines was due to the former firm. A skeleton drawing is given by Warren, page 306.

[3] The description of these engines has been derived from Mr. Robert Young's book "Timothy Hackworth and the Locomotive."

[4] An illustration of Galloway's engine in its earlier 2–2–0 and later 0–4–0 forms was given in THE ENGINEER of July 4th, 1924, by Mr. C. F. Dendy Marshall. The description given above refers to the later alterations to a coupled engine. The illustration in Stretton's "The Locomotive and its Development" is entirely incorrect.

[5] See THE ENGINEER, June 10th, 1881, page 432. Similar cowls were used on some of G. Stephenson's Killingworth engines.

[6] "Timothy Hackworth and the Locomotive," by Robert Young, M.I. Mech. E.

[7] "A Chapter in the History of Locomotion," page 19. J. Tomlinson described it as the idea of a draper in Darlington.

[8] The L. and N.W.R. 2–4–0 engine had the coupling-rods removed, and friction gear substituted. It was illustrated in the *Locomotive Magazine*, Vol. IX. (1903), page 350.

Gas Engineering in 1924.

THE industry associated with town's gas production and supply in this country is unlike most engineering industries in that it provides an essential commodity for which the demand varies but little in accordance with the general state of trade. Fluctuations in industrial activity certainly have their influence on the quantity of gas consumed, but the industry is in no sense the victim of periods of depression and prosperity, so that the demands of the future may be gauged with comparative accuracy and programmes laid down accordingly. The most striking fact about the gas industry, not only in Great Britain, but the world over, is that it never appears to approach any nearer to a stage of finality so far as the output of gas is concerned. Year after year the total amount of gas consumed continues to increase, and year after year the gas undertakings find it necessary to add to their manufacturing resources in order to satisfy the requirements of the public. This fact is not without a good deal of significance, for it is evident that the increased demand is by no means solely due to what may be styled new business; but is largely the outcome of an enhanced use of gas by individual consumers, who seem to be becoming more and more alive to the advantages of a gaseous rather than a solid fuel for all domestic, and many industrial, purposes. In this way, the general public is unconsciously adding its quota to the solution of the smoke problem, and it is quite possible that within the next decade nearly every householder will follow what has already become the quite common practice of limiting the open grates in the house to that one which is installed in the favourite sitting-room, the satisfaction and homeliness of which not even a gas engineer would attempt to deny.

The Trend of Carbonisation.

In reviewing the events of the past year, one is struck by the fact that there was a complete absence of that rather trivial criticism to which the gas undertakings had been subjected in full measure in the few years preceding. The therm seems at last to have established itself as an equitable unit, and even the most sceptical of consumers have ceased to denounce it as a clever commercial artifice designed primarily for concealing the cost of gas. From the gas engineer's point of view, it may certainly be said that as his experience with the therm system increases, so does he realise that it has in a sense revolutionised his ideas as to economic methods of carbonisation and gas supply, and it is undoubtedly owing to the therm that the technique of gasworks processes has in the last few years been viewed in an entirely different light, with the result that efficiency of production has increased enormously. It cannot be said that the past year was notable for any striking developments or innovations in the methods of producing gas, for it is now generally recognised that modern accepted methods are capable of little improvement as a whole, but that scope in the main lies in attention to, and elaboration of, specific details. The years immediately following the war witnessed the introduction of novelties which further experience has not altogether justified, the result being that expedients—such as the principle of the complete gasification of coal—which proved of considerable utility at a time when the coal market was in a state of dislocation, have lost the majority of their attractions now that the situation so far as raw materials are concerned approaches the normal.

To-day the attention of the gas engineer is divided between the continuously operated vertical retort, in which steaming is resorted to, and the familiar horizontal bench employed in conjunction with water gas plant. The outstanding object in view must always be that of obtaining the maximum yield of therms per ton of coal carbonised, and there can be little doubt that the vertical retort, with its yield of 85 therms, will continue to make headway in this country. That it is no longer regarded as unsuitable for the carbonisation of certain classes of the well-known series of Durham gas coals, is illustrated by the fact that at the end of the year the Gas Light and Coke Company placed an order for an installation, on the Glover-West principle, for its Nine Elms works, the capacity of the new unit being no less than 7,000,000 cubic feet per day. This fact is of more than ordinary interest, for it will be recollected that in 1922 the same undertaking decided to erect a bench of retorts operated on the same principle and of similar capacity at its Fulham works. It is important to note, moreover, that this company largely employs unscreened Durham coals.

The Production of Smokeless Fuels.

The situation as regards the utilisation of methods of low-temperature carbonisation by gas undertakings assumed particular importance during the year. It is well known, of course, that in the past gas engineers have always regarded low-temperature carbonisation as unsuited to the primary requirement which they have in view, namely, the production of gaseous energy. During the year, however, it was announced that an arrangement had been entered into between the Nottingham Corporation and the Low Temperature Carbonization Company, under which the town will take the gas produced by a plant to be put up by the company in conjunction with the Digby Colliery Company. At the outset the installation is to be made capable of handling 1000 tons of coal a day, and it is intended to produce 250,000 tons of smokeless fuel a year. The gas produced will amount to some 700 million cubic feet per annum, while there will also be available 7,000,000 gallons of crude oil and 1,000,000 gallons of motor spirit.

In addition, it was stated that the plant on the Maclaurin principle, which has for some time been undergoing construction at the Dalmarnock gasworks of the Glasgow Corporation, was towards the end of the year almost ready for service. Its coming into operation will mark the first occasion on which a gas undertaking has become a serious purveyor of smokeless fuel. In a paper which he read in November the inventor stated that the installation comprises five units, each designed to carbonise 20 tons of coal per day. With a gas yield of from 25,000 to 30,000 cubic feet per hour, a black type of smokeless fuel is produced, but with higher gas yields the fuel has a grey appearance. From tests carried out with an experimental plant at Grangemouth, it was found that from Scottish coals containing moisture of from 6 to 10 per cent. and volatile matter of from 33 to 35 per cent., smokeless fuel in amounts up to 55 per cent. could be obtained. The oil yield varied from 14 to 20 gallons per ton, according to the grade of coal used. At the Dalmarnock plant it is intended to use the gas produced in the smokeless fuel plant for heating vertical retorts and a steam boiler. With raw coal at 20s. per ton, the charges amount to 8s. 3d. per ton, so that the products of the plant must yield 28s. 3d. if the process is to be carried out on sound economical lines.

The Fuel Research Board continued to experiment with the problem of economically producing smokeless fuel, but the progress was somewhat disappointing, though many valuable data were obtained. The work carried out was mainly on the lines of breaking down a suitable blend of coals in a disintegrator, heating the mixture to a temperature just below the decomposition point, briquetting the heated coal under pressure without an added binder, and subsequently carbonising in a simple vertical retort of a type somewhat similar to those used in the Scottish shale oil industry.

A most favourable aspect of the whole situation was the closer contact which the Board endeavoured to maintain with private undertakings operating similar processes, the majority of these undertakings having kept the Board fully informed of the progress made, thus securing co-ordination of results in experimental development. Owing to variations in the coals available, and in local conditions, a number of different processes will possibly have to be devised before success on a national scale is achieved, and it is quite certain that no single process which would be suitable for application on a national scale has yet become established. Before it becomes feasible to prohibit the use of raw coal in our homes it is therefore necessary to find a process and a type of plant which collectively could pay their way when the raw coal was purchased at approximately the same price as coal now sold for household or other general purposes.

In July a test was carried out by the staff of the Board on an installation of Parker low-temperature retorts at the works of the Low Temperature Carbonization Company at Barugh, near Barnsley. The plant available consisted of two units, each capable of carbonising 50 tons of coal per twenty-four hours, and the test was carried out on one of these units, after it had been in continuous operation for eight days, on Dalton Main coal. The yield of semi-coke amounted to 13.92 cwt. per ton of coal carbonised, and it was found to be of very suitable size (1in. to 2in.). Moreover, it was not friable, and contained only 4.6 per cent. of breeze. Analysis showed that the volatile content (approximately 4 per cent.) was rather low, but when burned in a household grate the fuel ignited readily and gave a good hot fire. The tar, the yield of which was high, proved on

examination to be a normal low-temperature product, while the yields of ammonia and benzol obtained by "stripping" the gas were both satisfactory. It would seem, however, that the amount of fuel consumed in the plant was high, a fact which was ascribed to bad design of the combustion chambers and to indifferent heat insulation.

At the Fuel Research Station at East Greenwich some valuable investigatory work was conducted in connection with the carbonisation of Welsh coals. It was pointed out that the South Wales field is not specially rich in gas coal, and it is frequently necessary to resort to blending in order to ensure satisfactory working in continuous vertical retorts. A series of tests was undertaken in order to determine the effect of different degrees of steaming the charge, and it was particularly instructive to find that, whereas when steam at the rate of 5 per cent. of the weight of coal was admitted the yield was 74 therms per ton of coal, when the proportion of steam was increased to 20 per cent. the therm yield reached the remarkable figure of 88. The tar yield at 5 per cent. steaming was somewhat low, but an appreciable increase was obtained with higher proportions of steam. The increase in the yield of sulphate of ammonia was negligible beyond 12.5 per cent. of steam owing to the high temperature prevailing towards the top of the retorts, an effect of steaming which has been observed before with coals containing a low content of water. The great value of the experiments lies, however, in the fact that they should encourage the use of the vertical retort by those gas undertakings which have perforce to draw their coals from the Welsh fields.

Wembley and the World Power Conference.

The gas industry was remarkably well represented at Wembley and also at the World Power Conference, in which it figured prominently among the subjects discussed in the Gas and Fuel Section. The gas exhibit, which was housed in the Palace of Industry, represented the co-operative effort of the majority of gas undertakings and manufacturers of gas plant and appliances throughout the country. The exhibit cost some £80,000, and it faithfully portrayed the vast and multifarious service which gas is capable of rendering at the present day. It is interesting to note that gas was solely employed as a fuel in connection with the catering arrangements at Wembley, the consumption for cooking alone amounting to no less than 80,000 cubic feet per hour during the periods of the peak load.

At the World Power Conference held at Wembley in June it was pointed out that the gas industry had grown to be one of the most important in the country, as was illustrated by the fact that at the present time it carbonises in a year approximately 16 million tons of coal in addition to utilising 46 million gallons of oil. The gas produced per annum now amounts to no less than 250,000 million cubic feet, while 6 million tons of coke are obtained as a result of carbonisation. It was emphasised that one of the most valuable services rendered by the gas industry to the community was the conservation of the country's coal. Of the coal that goes into a gasworks nothing is wasted. Less than 12 per cent. of it is utilised to provide the heat necessary for its carbonisation; everything else is recovered in such forms as enable its full value to be realised—partly as gas, a highly efficient source of light, heat and power; partly as coke, a source of heat or power more efficient than its equivalent weight of coal; and partly as residuals. Both gas and coke supply these services without any of the befouling and darkening of the atmosphere which attend the crude use of raw coal in grates and under boilers. As tar, ammonia, and cyanogen, the residual products of gas manufacture and its purification provide the bases of an almost infinite number of chemicals substances which are lost to industry when coal is burned instead of being carbonised. These are the main facts upon which rests the claim of the gas industry to serve the two national causes of conservation of our dwindling coal supplies and the purification of the atmosphere of our towns and cities.

In an important paper urging co-ordination between suppliers of gas and electricity, Dr. E. W. Smith insisted that these two public services should never have been separated. He drew attention to the fact that the amount of coal required by gas undertakings as compared with electrical undertakings was as 6.6 to 2.7, but the number of therms sold by gas (as gas) and electrical undertakings was as 6 to 1, or 18 to 1 if coke were included. The gas and electrical industries are essentially public services, and in the majority of cases could be run more economically by putting them under single control. The electrical industry requires about 6.8 million tons of coal a year. The gas industry has available for sale eight million tons of coke, of which about one million tons is in the form of coke breeze of reduced market value. It is bought up largely by privately owned power stations for steam raising, and freightage becomes proportionately a large item. This material, with or without treatment, could be more profitably used by power stations attached to gasworks.

There can be no doubt that the principle of a single undertaking providing both gaseous and electrical energy is commencing to gain headway in this country, and during the year quite a number of instances could be pointed to—the majority in connection with quite small undertakings—where powers were sought by gas companies to distribute electricity. There was, too, a good deal of activity in connection with amalgamation of another kind, namely, between separate gas undertakings supplying adjacent areas. In fact, one of the most significant features of the year was the announcement relating to the absorption of the Brentford Gas Company—the third largest in London—by the Gas Light and Coke Company. This amalgamation forms by far the largest in the history of the British gas industry, and when completed it will involve the Gas Light and Coke Company, already by far the largest undertaking of its kind in the world, in an annual distribution of approximately 40,000 million cubic feet of gas and the carbonisation of nearly 2¼ million tons of coal. The output of the Gas Light and Coke Company will accordingly represent no less than one-sixth of the whole of the gas consumed in Great Britain.

It may be said with a good deal of certainty that the process of grouping among gas undertakings is likely to be considerably accelerated within the next few years. If the gas industry is to continue to progress and expand at the present rate it is essential that the price of the therm should be lowered, but little relief can be looked for in the cost of raw materials and labour. By, however, the elimination of the smaller producing units, permitting of manufacture in bulk, a great opportunity is presented, particularly in London, at the present day. The Gas Light and Coke Company seems bent on a programme which should ere long place the whole of the metropolitan and suburban areas north of the Thames within its authority, a consummation which would not only react enormously to the advantage of the vast gas-consuming public in London, but which should prove a most effective weapon in meeting electrical competition.

Coke and other Residuals.

The past year opened full of promise from the point of view of the coke market, for stocks were at a minimum and there was every indication that prices would be fully maintained. Towards the end of the year, however, there was an appreciable decline in the demand for export, stocks showed signs of swelling, and in many instances the price was lowered by some 2s. per ton in order to attract buyers. The gas coke market is beginning to feel the incidence of the state of affairs in the metallurgical industry, for manufacturers of metallurgical coke when faced with inactivity in the iron and steel trade have begun to turn their attention to markets which have hitherto been regarded as the preserves of the gas industry. The competition thus introduced has not as yet reached serious proportions, but it demands careful attention from the standpoint of the preparation and marketing of gasworks coke. Renewed attention was given to the highly important question of quality of the gasworks product. It has come to be recognised that the consumer of solid fuel is growing far more discerning in his choice, and the criticism which has been levelled at some varieties of gasworks coke has led to a welcome improvement in the methods of quenching, screening and grading.

A good deal of attention was attracted during the year by methods of dry-quenching, which appear to have been utilised with success on the Continent. One such method—known as the Sulzer system—was fully described in THE ENGINEER of May 9th. In the dry-cooling process the glowing coke is enclosed in an air-tight chamber and an inert gas circulated through it. In practice it does not become necessary to supply this gas, as the air in the coke containing chamber gives up nearly all its oxygen when it passes through the coke for the first time, leaving an inert gas—namely, nitrogen—in the chamber. The gas is circulated by a specially designed fan through boiler tubes, and transfers the heat in the coke to the water in the boiler, thus raising steam. By this means the temperature of the coke is reduced from about 2000 deg. Fah. to 400 deg. Fah., and steam may be raised in the boiler at any desired pressure, or large quantities of hot water may be produced. The dry coke is of a bright, light grey colour, and as it contains no moisture, its heating value is higher than that of coke cooled by the wet process. It is also produced in larger and more compact pieces, reducing greatly the amount of less valuable breeze and unsaleable dust. The steam produced by the plant may be used for a variety of purposes in a gasworks, and on a large installation it may be safely predicted that if it is used to generate electricity there will be not only enough current for the works, but it is quite possible that extra current will be available for sale at a profit to outside consumers.

The market for tar was extremely disappointing; in fact, at one period in the year prices seemed almost to collapse. At the beginning of the year the price stood at about 70s. per ton, but in December it was no better than 35s. The principal tar products followed suit, pitch in particular being a weak market, the price falling from 78s. in January to some 50s. at the end of the year. There is little question that at the present time coal tar is experiencing a good deal of serious competition from bitumastic materials.

The situation as regards sulphate of ammonia was of exceptional interest owing to the fact that for the first time in the history of the country synthetic ammonia was produced and marketed on a large scale. Actually the large scale plant erected at Billingham-on-Tees was brought into operation on Christmas Day, 1923, and has been working continuously ever since. It is, moreover, understood that developments are to continue and that designs are in hand for increasing the size of the plant to produce 300 tons of sulphate of ammonia daily, after which it is hoped to manufacture nitrate of ammonia and urea. It is important to note that the Brunner-Mond organisation has thus far marketed its synthetic gaseous product as sulphate of ammonia, for it has become more or less common knowledge that sulphuric acid as such is not being used, but that the acid-radicle is obtained from anhydrous calcium sulphate, large quantities of which were found to occur on the Billingham site. The process which is being followed would seem then to consist of reaction between ammonia, calcium sulphate, and carbon dioxode, which directly yields sulphate of ammonia and calcium carbonate. This fact is one of immense importance, for there seems little doubt that the acid-radicle can be obtained from anhydrous calcium sulphate at a price of half that at which sulphuric acid is available to those who manufacture sulphate of ammonia from by-product ammonia.

PULVERISED COAL.

THERE was a large attendance of members of the Manchester Association of Engineers at the meeting held on Friday, January 16th, to hear a paper on the subject of pulverised coal by Mr. R. Jackson, A.M.I. Mech. E. The author enumerated the advantages derivable from the combustion of coal in the pulverised form, and laid down the conditions which should be fulfilled in the process. He described with the aid of lantern slides the several best known types of plant for the preparation of the fuel, including multiple or storage apparatus and the unit or self-contained plant, the former including the Lopuloo, Fuller, Holbeck, Bonnot, Raymond and Sturtevent mills, which, the author said, were only suitable for large installations. Amongst impact mills, the author gave particulars of the aero or turbo, Simon Carves, Erie City and the Atritor mills, the Carr, K.E.K., and the Brierley apparatus. Mr. Jackson claimed the following advantages for pulverised coal:—Reduction of stand-by and other losses to a minimum; excellent combustion conditions, with a minimum of excess air, almost carbon-free ash, and smokeless chimney; entire absence of moving parts within the furnace; reduction of the time lag or inertia period when raising steam and meeting fluctuating steam demands; efficient use of all grades of cheap and inferior coals; reduction in labour and ease of regulation to maintain high efficiency. The author described some of the methods employed for cooling the combustion chambers, such as the C. E. Fin and Foster systems, and said that the application of pulverised coal firing to metallurgical furnaces pointed the way to large economies. He prophesied that the low-temperature carbonisation process would in the future deal with our best coals, giving, in addition to valuable oils, gases and sulphates, a smokeless fuel which could and would be burned in pulverised form. Mines would adopt the logical method of bringing all their fine coals to the surface and working all available seams, instead of leaving unsaleable coals unworked, or laboriously stone dusting all their workings.

The discussion which followed the reading of the paper was somewhat marred by the introduction by several speakers of considerations which were outside the legitimate scope. The increased efficiencies claimed by the author were criticised, and the complications involved were commented upon.

THE WATER RESOURCES OF CANADA.

THE Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has published a new volume of that portion of the series of water resources papers which deals with the surface water supply of Canada. This report, which is No. 42 of the series, gives details of the stream measurements made in the province of Ontario during the climatic year from October 1st, 1922, to September 30th, 1923.

It should be explained that the Dominion Water Power and Reclamation Service of the Department of the Interior is engaged in making a systematic survey of the water resources of the whole of the Dominion. For convenience in the administration of a survey covering so great an area, the country is divided into four major districts, the boundaries of which are arranged to correspond as far as possible with the watersheds dividing the great river systems of the northern part of the continent, but which must necessarily to some extent be governed by provincial and territorial boundaries. A separate series of stream measurement reports is published for each of these four divisions, and they cover respectively the Atlantic drainage south of St. Lawrence River, including Nova Scotia, New Brunswick, Prince Edward Island, and South-Eastern Quebec; the St. Lawrence and Southern Hudson Bay drainage in Ontario and Quebec; the Arctic and Western Hudson Bay drainage (and Mississippi drainage in Canada), in Alberta, Saskatchewan, Manitoba, extreme Western Ontario, and North-West Territories; and the Pacific drainage in British Columbia and the Yukon Territory.

The present report is one of the second series above described. It contains a short explanation of the purpose and scope of the work and seventy-nine pages of tables and descriptions of gauging stations, with an index map of Ontario showing their location. It will be supplied free of charge on application to the High Commissioner for Canada, Kinnaird House, Pall-mall East, London, S.W. 1, or to the Director of Water Power and Reclamation, Ottawa, Canada.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. IV.—SCANDINAVIA.*

1. Historical: Reasons for Electrification.

Norway and Sweden have very small coal resources. Such coalfields as exist in the south of Sweden are quite inadequate, and the coal is of a poor quality. On the other hand, the water power supplies are abundant, and railway electrification on a large scale has been contemplated, in order to reduce the quantity of imported coal.

In *Sweden* the question has been studied since 1899, when a Royal Commission was formed to draw up a scheme of hydro-electric developments for railway traction. The preliminary investigations were completed in 1902, and in the next year a grant was obtained for the construction of an experimental line near Stockholm, to work with single-phase energy at 6000 to 20,000 V. Trials on this line were completed in 1907. The Riksdag in 1906 granted the necessary money for purchasing waterfalls suitable for hydro-electric schemes, and ultimately the first proposal for the electrification of a large section of the Swedish State Railways—the Kiruna–Riksgränsen line—was put forward in 1910. In selecting this line for the first electrification, the coal consumption for the State Railways would be considerably reduced, and the electric system would be tested under the most severe conditions. The Riksdag authorised the construction of the line and of a power station at Porjus, which had also to supply power for mining operations at Kiruna and Gellivare, as well as for the railway. The electrification enabled experiments to be made with the various methods of equipping the track, and with various types of electric locomotives. It was not possible, however, to gain any experience with suburban services on this line, but the Railway Administration considered that sufficient data on this subject had been obtained in other countries. In November, 1911, therefore, a scheme was put forward for the electrification of the short lines Stockholm–Märsta and Gothenburg–Alingsas, for which, however, no money was granted at that time by the Riksdag. The Administration considered, even then, that the electrification of the whole State Railway system should be carried out as soon as possible, although this proposal was not presented to the Riksdag.

On November 6th, 1914, power was supplied from Porjus hydro-electric station, and by July 14th, 1915, all trains on the Kiruna–Riksgränsen line were worked electrically, since when the service has been maintained without interruption.

In 1916 the Administration put forward a scheme to extend the electrification southwards to Lulea and Svartön, including all the railway system for the transportation of minerals in Norrland—the northern part of Sweden. The Riksdag authorised the Kiruna–Gällivare and Gällivare–Nattavaara sections in 1917, and the Nattavaara–Svartön line in 1920. The line Kiruna–Gällivare was opened for electric service in 1920, and the electrification was ready down to Svartön in 1922.

Thorough investigations have been made with a view to extensions in other parts of the country. The order in which further schemes should be carried out was examined. As the chief point is to make the railways independent of foreign coal, those lines with the highest coal consumption should naturally be electrified first. At the same time, practical considerations made it desirable to equip the lines in groups.

Two Royal Commissions in 1920–1922 have studied the problems connected with the electrification of the Stockholm–Gothenburg line, which was authorised in 1920, on condition that the power should be generated and transmitted in the most economical way for the country, and that the telephone and telegraph lines should not be interfered with. The unexpected fall of the cost of coal in 1921, and the difficulty in raising the necessary capital, caused some delay.

Several of the Swedish privately owned railways are already electrified, as indicated in Table I. below :—

Table I.—*Privately Owned Electric Railways in Sweden.*

Line.	System.	Length, kilom.	Year of opening.
Stockholm-Djursholm ..	D.C. 600 volts	15	1893
Hälsingborg-Ra-Ramlösa	D.C. 600 volts	8	1906
Mellersta Östergötland ..	A.C. 10,000 volts, 25 per.	72	1908–1915
Stockholm-Saltsjöbaden .	D.C. 1200 volts	18	1913
Lund-Bjärred	A.C. 16,000 volts, 16⅔ per.	11	1916
Nordmark-Klarälven ..	A.C. 16,000 volts, 25 per.	150	1921–1922

In *Norway* a few small lines are operating electrically. The Thamshavn–Lökken mineral line in the Trondhjem district has been working since 1908, and the Rjukan Railway since 1912, of which the Notodden–Tinnoset section has been taken over by the Norwegian State Railways. The Administration of the latter extended the electrification of the Swedish Riksgränsen line as far as Narvik, on the Atlantic coast, in 1923, and electrified the Kristiania–Drammen line in 1922. All these are single-phase railways. With a view to continuing the electrification schemes, the Storting has purchased a number of waterfalls in Norway, and has investigated the most suitable lines for electric traction.

* No. III. appeared June 20th, 1924.

2. Choice of System.

The first post-war Swedish Commission appointed to study the problem of the electrification of the railways issued its report on January 10th, 1920. On account of the extreme urgency arising from the scarcity and high price of coal, it was decided to limit the inquiry to the electrification of the Stockholm–Gothenburg line. A proposal to use battery vehicles was discarded on account of their excessive weight and the difficulties in maintenance. A system employing conductors running along or above the track was required.

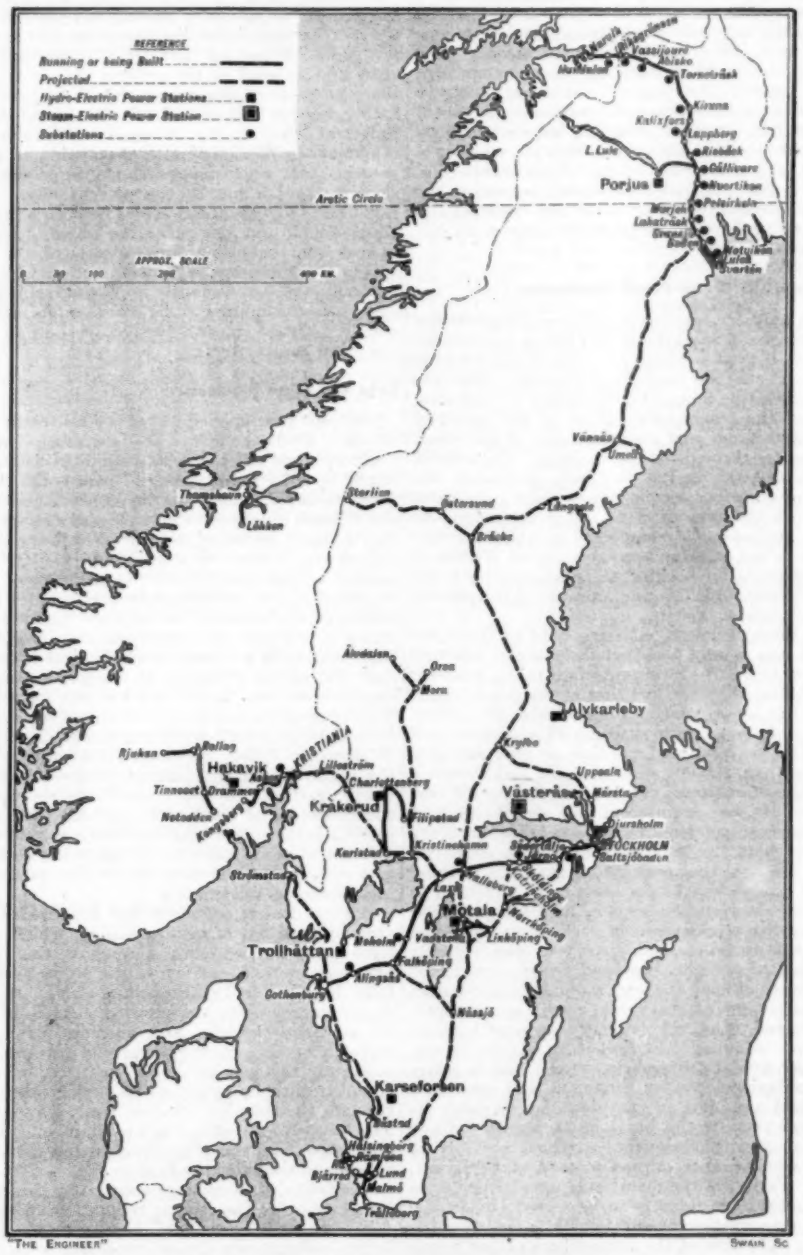


FIG. 1—MAP OF SCANDINAVIA SHOWING ELECTRIFIED RAILWAYS

With 3-phase operation at about 15 cycles and 3000 volts, two overhead contact wires are required. In spite of its obvious advantages, the Commission decided that the system possessed too many drawbacks compared with the direct-current and single-phase systems, so that the inquiry was confined to the two latter.

The D.C. system appears to be preferred in America and in France, and is, moreover, the most common system, owing to its development for short lines. For main-line schemes, however, high-tension D.C. is necessary to keep down the number of sub-stations. A pressure of 5000 V. is technically feasible, but since at 3000 V. the cost of the locomotives and motor-generator sets is already about 50 per cent. of the total expenditure, owing to the insulation difficulty, the latter voltage cannot be economically exceeded. Mercury rectifiers had not been developed up to that time for heavy railway service, making motor-generators essential.

The single-phase system is favoured in Germany, Austria, Switzerland and Norway. The type of motor now employed—the neutralised-series machine—has practically ousted all rivals. It is a low-voltage motor and needs a transformer, which, by providing different pressures, yields economical speed control. The machine has a somewhat lower efficiency than the D.C. motor. The standardised voltage of 15,000 V. for the overhead lines has proved satisfactory for all traffic conditions, and appears to be quite reasonable. A low frequency is desirable, both for the motor and the control gear, and 15 or 16⅔ (= 50/3) periods meets requirements. A simple ratio between the traction and the industrial frequency is in many cases most desirable. It must be remembered that the supply of single-phase railways from normal-frequency networks demands the use of rotary machinery in the sub-stations.

In considering the relative merits of the 3000 V. D.C. and the 15,000 V. single-phase systems, the Commission had the results of the Chicago, Milwaukee and St. Paul Railway for the former, and their own Riksgränsen Railway for the latter. With regard to telephonic and telegraphic interference, both systems have given trouble, and, in addition, the D.C. system may also give rise to electrolysis. With either it appears to be necessary to remove the communication circuits to a distance of at least 15 m. from the track. Short circuits on the contact line are most troublesome, but means are available for reducing their effect with either system. The same is true of tooth ripples. The Commission considered the systems about equal as regards interference with communication circuits; the good results on the C. M. St. P. Railway being attributed to the quick breaking of short-circuits preventing the rise in pressure in the weak current lines. The use of "milking transformers" is equally effective with the single-phase system.

Coming to the locomotives, the weight per horse-power is about the same for both systems, considering the different limits obtaining in Europe and America

TABLE III.—SCANDINAVIAN MAIN LINE ELECTRIFICATION.

Railway.	No.	Section.	GENERAL: Date opened for electric traction.	Route length. km.	No. of tracks.	Gauge. m.	No. of intermediate stations.	Mean distance between stations. km.	Max. grade. °/₀₀	Radius of min'm curve. m.	Type of rail.	Rail weight, kg./m. Length per rail. m.	Max. allowable speed. km./hr.	CONTACT LINE: Current voltage and frequency.	Contact line.	Return.	Contact line suspension.	Description and spacing of supports.	Insulation.	POWER SUPPLY: No. of feeding points.	Feeding points.	Mean length of line per feeding point. km.	Feeding lines.	Transmission lines.	Power stations.
SWEDISH STATE RAILWAYS	1	Kiruna-Riksgränsen	1915	130	1	1.435	14	10	10	500	Vig.	40.5/10	100 km. per hour for express	Single-phase, 15 periods, 16,000 volts	Copper contact wire, 80 mm², stretched at 8 kg. per mm². Copper catenary wire, 50 mm².	Rails	Simple catenary 5.6 m. above track. Contact wire hung from catenary wire at the supports and at two to five intermediate points. Catenary sag 1.2m.	Spacing 52.5 m. on open tr'k; 60 m. in stations. Iron lattice supports	Single	13	*Transformer sub-stations*: Notviken, Boden, Granasjö, Lakaträsk, Polcirkeln, Nuortikon, Gällivare, Risbäck, Lappberg, Kiruna, Torneträsk, Abisko, Vassijaure	33	None	80,000 single-phase transmission line along track, carried on iron 3 or 4-legged masts, fed from Porjus station. Span about 200 m. Four wires for two duplicate circuits, cross section 80, 70, 60, or 50 mm².	*Porjus* (hydro-electric): head 52 m. Three sets each:—1 turbine, 14,000 H.P., 225 r.p.m., driving 10,000 kVA, 15 per., 1-phase generator. Also standby and 3-phase, 25 per., equipment
		Gällivare-Svartön	1922	204	1	1.435	23	9	12.5	300	Vig.	40.5/10													
	2	Stockholm-Gothenburg	End of 1925	458	2 for 98 km. 1 for 360 km.	1.435	70	6.5	10	600	Vig.	40.5/10	90 km. per hour for express	Single-phase, 16⅔ periods, 16,000 volts	Copper contact wire, 80 mm²., stretched at 8 kg. per mm². Copper catenary wire, 50 mm².	Copper conductor, 150 mm².	Simple catenary 5.6 m. above track. Contact wire hung from the catenary at the supports and at five intermediate points	Spacing 60 m. Iron lattice supports	Single	5	*Motor generator sub-stations*: Alingsas, Moholm, Hallsberg, Sköldinge & Södertälje	92	None	General three-phase network	50 per., 3-phase hydro-electric stations at *Trollhättan, Motala and Alfkarleby*: steam and electric at Västerås
NORWEGIAN STATE RAILWAYS	3	Kristiania-Drammen	1922	53	2 for 13 km., 1 for 40 km.	1.435	16	3.5	15.87	250	Vig.	35/12	80 km. per hour	Single-phase, 15 periods, 16,000 volts	Copper contact wire, 80 mm², stretched at 9.5 kg. per mm². Copper catenary wire, 50 mm².	Rails	Simple catenary 5.5 m. above track. Contact wire suspended from catenary at the supports and at two intermediate points	Spacing 60 m. Iron lattice supports	Single	1	*Transformer sub-station*: Asker	53	Asker-Bragerön and Asker-Sandviken, together 38 km.	60,000 V. single-phase transmission line fed from Hakavik power station, carried on 4-legged iron masts. Span about 180 m. Four wires for two duplicate circuits, 35 mm.² each	*Hakavik* (hydro-electric), head 390 m. Three sets, each of 1 turbine, 5000 H.P., 300 r.p.m., driving 2700 kVA, 15-cycle, single-phase generator
	4	Riksgränsen-Narvik	1923	42	1	1.435	6	7	17.5	300	Vig.	40.5/10	60 km. per hour		Copper contact wire, 80 mm², stretched at 6.4 kg. per mm². Copper catenary wire, 50 mm².		Simple catenary 5.5 m. above track. Contact wire suspended from catenary at the supports and at one to five intermediate points			2	*Transformer sub-stations*: Hundalen and Narvik	21	None	80,000 V. single-phase transmission line along track, fed from Porjus station	*Porjus* (hydro-electric). see above

TABLE IV.—SCANDINAVIAN ELECTRIC LOCOMOTIVES.

Railway.	Section.	Rolling stock.	Number.	Axles: Driving.	Axles: Pony.	Axle arrangement.	Weight: Total. Tons.	Weight: Adhesive. Tons.	Weight: Electr. equipment. Tons.	Weight: Per axle. Tons.	Length over buffers. m.	Wheel base. m.	Wheel diameter: Driving. m.	Wheel diameter: Pony. m.	Motors.	Motor volt'ge. v.	No. of motors.	Loco. H.P. (1-hour).	Tractive effort (1-hour). kg.	Speed (1-hour). km./hr.	Speed, max. km./hr.	Weight per H.P. kg.	Drive.	Gear ratio.	Speed regulation.	Current collectors	Number of transformers.	Cooling of transformers.	Braking.
SWEDISH STATE RAILWAYS	Riksgränsen-Svartön	Locos., Express	2	2	4	2 B 2	90	33.4	35	16.7	14.05	10.1	1.575	0.97	Single-phase neutralised series.	200	1	900	5,400	45	100	100	Direct by conn. rod	—	Variation of secondary voltage on transformer.	Pantographs.	1	Oil	Air
		Locos., Express	2	4	4	2 B + B 2	123	63	49	15.8	21.45	16.2	1.35	0.97		270	4	2200	9,100	65	100	56	Gear and jackshaft	1.76			2	Oil	Air
		Locos., Mineral	17	6	2	1 C + C 1	138	105	63	16.7	18.62	14.6	1.1	0.73		200	2	1700	15,300	30	60	72	Direct by conn. rod	—			2	Oil	Air
		Locos., Mineral	16	6	2	1 C + C 1	127	101	52	16.8	20.93	16.6	1.53	0.85		370	4	2800	20,000	38	60	45	Gear and jackshaft	4.89			2	Oil	Air
		Loco., Passenger	1	2	2	B — 2	52	31	17	15.6	14.1	9.7	1.3	0.97		200	2	450	2,700	45	75	116		2.59			1	Oil	Air
		Locos., Freight	2	4	0	B + B	68	68	26	17.3	12.9	8.3	1.35	—		400	2	1000	11,700	30	60	68		4.45			1	Oil	Air
		Locos., Freight	10	4	0	D	69	69	27	17.25	11.3	6.35	1.35	—		260	2	1100	10,000	30	60	63		3.83			1	Oil	Air
	Stockholm Gothenburg	Locos., Express, or freight	50	3	2	1 C 1	79	51	30	17	13.0	9.4	1.53	0.97		390	2	1700	8,500 11,500	54 40	90 70	46	Gear and jackshaft	3.19 4.24			1	Oil	Air
NORWEGIAN STATE RAILWAYS	Kristiania-Drammen	Locos., Passenger, and freight	22	4	0	B + B	61	61	22	15.2	12.7	8.8	1.445	—		290	2	940	7,700	33	60	65	Gear and jackshaft	4.27*			1	Oil	Vacuum
		Locos., Freight	2	4	2	1 B + B 1	77	55	29	13.8	14.78	11.5	1.445	0.988		520	2	1150	10,000	31	50	67		5.24			1	Oil	Vacuum
	Riksgränsen Narvik	Locos., Mineral	4	6	2	1 C + C 1	135	103	59	17.2	21.12	16.4	1.53	0.988		380	4	2800	19,000	40	60	48	Gear and jackshaft	4.78			2	Oil	Air and regenerative
		Locos., Mineral	2	6	2	1 C + C 1	135	103	58	17.2	19.27	15	1.25	0.988		515	4	2800	20,500	37	60	48		3.22			1	Oil	

for railway operation. In America it would appear that the upkeep of the three D.C. types—geared, direct-mounted, and connecting-rod drives—is the same per ton weight, while that for the old single-phase 25-cycle locomotives is twice as much. European upkeep costs of single-phase locomotives, based on data obtained from the Riksgränsen and Lötschberg lines, are comparable with those of the American D.C. locomotives. However, the Commission decided to assume that the upkeep of single-phase locomotives is 25 per cent. greater than that for the D.C. machines. With regard to drive, recent experience in Germany and Switzerland has led to the adoption of gears and side rods instead of only connecting-rod drives.

It has been found that the energy consumption and efficiency of locomotives of the two systems are practically identical. With short distances between stations, the two are equal, while with longer distances the D.C. locomotive has a slight advantage in efficiency. The mean energy consumption at the collector bow, based on available evidence, has been taken as 22 Wh per ton-km. for single-phase, and 21.5 for D.C. locomotives.

Besides technical soundness, the system must be chosen also with reference to the smallest initial and yearly expenditure (working costs, interest and depreciation), the possibility of extension as traffic increases, and, further, the economical generation of energy.

For the Stockholm–Gothenburg line, the calculated peak load for the same traffic as in 1913 would be 17,000 kW. Double this amount is expected for the year 1925, and the calculated figure for the maximum quarter-hour load is 30,000 kW. The traffic is estimated to reach 3300 million ton-km., which, according to the assumed energy consumptions, would require 72.6 million kWh single-phase and 71 million kWh D.C. energy per annum at the collector bows.

In the case of the single-phase system, it was examined whether it would be better to generate single-phase energy direct for the railway or to draw three-phase energy from the existing or proposed main transmission lines and convert it to single-phase, or whether it was preferable to combine these methods and to equalise the load according to the conditions prevailing at any given time, assuming the three-phase network to be large enough to be uninfluenced by railway load fluctuations. The sections, for the purposes of calculation, were at this time (1920) limited to 30 km. in length, in order to reduce telephone disturbances.

Six possible arrangements were examined in great detail, the results being summarised in Table II.:—

TABLE II.—*Comparison of Systems for the Stockholm-Gothenburg Electrification.*

System.	Initial cost, millions of kr.*	Yearly cost, millions of kr.*	Per cent. yearly cost.
1. Single-phase generation at Motala: Conversion three-phase to one-phase at Trollhättan; load equalisation at Hallsberg ..	97.170	12.663	100
2. Three-phase to one-phase conversion in eight sub-stations, each feeding two sections	94.560	12.980	102.5
3. Three-phase to one-phase conversion in four sub-stations, with one-phase feeders along the track	96.350	13.046	103
4. Three-phase to direct current, conversion in sixteen sub-stations	100.850	13.189	104
5. Single-phase generation at Motala and Trollhättan	96.490	13.329	105.3
6. Three-phase to one-phase conversion in sixteen sub-stations ..	98.590	13.686	108

* Par value of kroner: £1 = 18.159 kr.

A detailed examination thus shows the difference between the systems to be small. The Commission, in recommending the first (No. 1 in the table), suggested that competitive tenders be called for, and that the expected results of the protective devices to reduce telephonic interference on the Riksgränsen Railway be considered before a final decision was reached. Attention was also drawn to the fact that, while not technically inferior to the D.C. system, the single-phase system is better adapted for future extension, and is also preferable on lines where traffic is sparse. For the Stockholm–Gothenburg line, then, it was proposed that single-phase energy should be generated at Motala, and three-phase energy converted to single-phase at Trollhättan, while the load should be equalised at Hallsberg; the overhead line should be fed at 15,000 V. 16⅔ periods. This proposal was later modified.

The suggested order of electrification of the Swedish lines was as follows (see Fig. 1):—

1. Riksgränsen–Lulea and Svartön.
2. Stockholm–Gothenburg.
3. Järna and Katrineholm Trälleborg.
4. Stockholm–Bräcke.
5. Malmö–Gothenburg.
6. Krylbo–Hallsberg.
7. Nässjö–Falköping.
8. Laxa–Charlottenberg.
9. Bräcke–Storlien.
10. Bräcke–Boden.
11. Gothenburg–Strömstad.
12. Kristinehamn–Orsa.

Of these, the first is completed and the second is under construction. The economy effected by electrification, under pre-war conditions, is shown to be slight; but when coal becomes expensive the increased economy is pronounced. In the Bill (presented to the Riksdag in 1920) containing the report of the Commission, it was estimated that the work on the Stockholm–Gothenburg line could be completed this year at a cost of 105 million Kroner, of which about 40 million Kroner would be required to provide 120 locomotives. The steam locomotives so released would be sufficient to render renewals on the other State lines unnecessary. So long as the price of coal exceeded about 45 Kr. per ton, electrification would result in a saving, while at the costs ruling in 1920 the capital outlay would be repaid in four years. The Riksdag committee considered that the problem of interference with communication circuits could be solved, but it made the necessary grant conditional upon a successful solution being found. Both Chambers passed the Bill, and two new Royal Commissions were appointed to deal with the question of transmission, energy conversion and interference.

In the final reports of both these Commissions, which were made in the beginning of 1923, the single-phase system was recommended for the Stockholm–Gothenburg electrification for the following reasons:—

The experience from the Nordmark–Klarälven line—a privately owned railway in the southern part of Sweden—showed that from the interference point of view, it was possible to operate a single-phase railway of 150 kilometres in length with only one feeding point at the middle and no sectionalising arrangements or other feeding lines than the trolley-line for the railway. Further new researches on the Svartön–Riksgränsen line showed that it was possible to reduce the inductive potential on telephone and telegraph lines to a very high degree, and also to avoid interference from higher harmonics.

The inductive potential on telephone and telegraph lines paralleling a single-phase road, measured without any compensating arrangements, was about 8 volts per 100 ampère-kilometres, but experience has shown that this figure can be reduced to only 0.02 volt by using sucking (milking) transformers in connection with insulated copper conductors for the return current. Thus, for 100 ampères flowing from Stockholm to Gothenburg, a distance of 458 kilometres, the inductive potential would, without compensating arrangements, have been 3660 volts, but will not now amount to more than 9 volts. Experience also has shown that the milking transformers can be made so that higher current harmonics can be compensated.

For these reasons it was no longer thought necessary to divide the contact lines for electrified railways into sections of about 30 kilometres; on the contrary, it was possible to propose that the contact lines for the Stockholm–Gothenburg electrification should be fed from five places only, and that these feeding points could be placed where the main 50-cycle network of the State three-phase transmission lines were already crossing the railway. The distances between these feeding points vary from 80 to 125 kilometres.

In order to get the best safety of operation it was desirable to operate the trolley line in a number of independent parts fed from one end. This could be accomplished without any difficulty, and the trolley line will thus be operated in separate sections varying in length from 40 to 60 kilometres. On account of the thus improved technical conditions it was no longer necessary to generate the electric power specially in the power stations, but the electric energy could be taken from the State power mains and converted to single-phase by means of motor generators at the feeding points.

At the beginning of 1923 the State Railways Administration made a new investigation into the economical result of this proposed electrification, and found then that the altered technical and economical conditions indicated that the costs of electric and steam operation would be equal at a price of coal of only 17 Kroner per ton. However, it now seemed advisable to figure with a 25 per cent. reduced traffic, when the costs of electric and steam traction would be equal with coal at about 26 Kr. per ton.

The total cost of the Stockholm–Gothenburg electrification, including electric locomotives and alterations to the telephone and telegraph lines, will now be 39 million Kroner.

The new proposal of the Railways Administration for this electrification was authorised by the Government and the Riksdag in June, 1923. According to the present programme the electrification will be completed at the end of 1925.

3. EXTENT OF THE PRESENT ELECTRIFICATION.

The map of Scandinavia—Fig. 1—shows the present main lines running electrically, under construction, or projected, together with some of the important privately owned railways. Technical data of the important sections are given in Table III., and locomotive details in Table IV, page 99.

SOME new grain-handling wharves are to be put up at Trafford Park, by the Manchester Ship Canal Company, at a cost of about £300,000.

Water Supply in 1924.

No. II.*

Repairing a Damaged Reservoir.

A particularly interesting piece of work was completed during the year when the reconditioning of the Shire Oak Reservoir of the South Staffordshire Waterworks Company was successfully terminated. This reservoir was built some twenty-eight years ago and very shortly showed signs of cracking owing, it is said, to subsidence caused by colliery workings beneath it. The cracks eventually became so extensive that the reservoir would no longer hold water and had temporarily to be abandoned. It was not until after the war that, subsidence having apparently ceased, the work of again making the reservoir serviceable was undertaken. It was decided to cover the floor and line the walls with reinforced concrete, using a bituminous substance both in the cracks themselves and for some distance over the surfaces on each side of the cracks. In the floor the concrete slabs in the neighbourhood of the cracks were laid with spaces between them which were filled with the plastic substance, while in the walls, expansion joints of special construction were employed. As it is intended to use the reservoir for filtered water, it was covered in with a concrete roof carried on reinforced concrete piers, the foundations of which were carried down through the floor. A view of the reconditioned reservoir was given in the Supplement published with our issue of the 2nd inst.

The Ryburn Scheme of the Wakefield Corporation.

The Corporation of Wakefield obtained during the year an Act to enable it to carry out the following works, which comprise what is known as the Ryburn scheme:—(*a*) Baitings Reservoir, which will have an earthen embankment 134ft. high and will contain 384 million gallons; (*b*) Ryburn Reservoir, which will have a concrete and masonry dam 100ft. high and a capacity of 222 million gallons; (*c*) Parrock Nook Catchwater, 1¼ miles long; (*d*) Gilbert Gulley Catchwater, 250 yards long; (*e*) trunk mains, 18in. to 22in. diameter, 23¼ miles long; (*f*) tunnel, half a mile long, through Barkisland Hill; and (*g*) mechanical filtration plant to deal with 2½ million gallons per day. The yield from this scheme for supply purposes will be approximately 2,600,000 gallons per day, and, in addition, compensation water to the amount of approximately 1,300,000 gallons per day, will be delivered to the stream. The river Ryburn is a tributary of the river Calder, and the catchment area and reservoir works will lie partly in the Urban District of Soyland and partly in that of Rishworth. The estimated cost of the complete scheme is £950,000. During the later part of the year surveys and plans were made for the pipe line, tunnel and filtration works, and constructional operation on that part of the scheme will be begun during the present year.

New Scheme for Perth.

The existing waterworks of the city of Perth were laid out in 1832. They provide for the abstraction of water from the gravel substratum of an island in the river Tay within the city. The water is pumped to four service reservoirs at different elevations, from which it is distributed. For a number of years the quality of the water supplied has been under suspicion, and the Town Council has for some time been considering the possibility of introducing a gravitation scheme from an uncontaminated source. Latterly, on their instructions, Messrs. Crouch and Hogg, chartered civil engineers, of Glasgow, have been investigating a scheme of supply from Loch Ordie, which is situated about 5 miles north of Dunkeld, and distant about 20 miles from Perth. Loch Ordie is 949ft. above sea level, and under the scheme would be converted into a storage reservoir. Gaugings and surveys were carried out during the year, and a final report was presented at the end of the year. The estimated cost of the scheme is about £300,000.

Guernsey's New Supply.

The waterworks of Guernsey were taken over from a company in 1921 by the States, or local governing body of the island. Prior to that time, a shortage of water had been experienced, and it was naturally intensified by the drought of that year. Immediate steps were taken to obtain an additional supply, and it was eventually decided to construct new works at a point known as King's Mills on the largest stream in the island. The works, which are designed to deal eventually with 720,000 gallons of water per day, comprise a settling reservoir with a capacity of 700,000 gallons, a pre-filter composed of granite chippings, open sand filter beds, clear water tanks and pumping machinery. The first section of the works capable of dealing with 10,000 gallons per hour was got to work in July, 1923, the second being brought into service in June, 1924. The plant at present in operation, which represents two-thirds of the works as they will eventually be, consists, in addition to the reservoir and pre-filter, of three open sand filter beds—two of sufficient area to deal with 5000 gallons per hour each and one with 10,000

* No. I. appeared January 16th.

gallons per hour—two covered clear water tanks and two sets of vertical three-throw plunger pumps, each capable of dealing with 10,000 gallons of water per hour against a head of 279ft., and each driven by a crude oil engine of 34 horse-power. We understand that the fuel consumption works out at 0.53 lb. per pump horse-power hour, and that the total working cost of the plant, without labour, is 1.14d. per 1000 gallons pumped.

Works under Construction or in Contemplation.

The work on the Scar House reservoir of the Bradford Corporation waterworks department proceeded satisfactorily, notwithstanding the fact that the winter was severe and the spring and early summer were unusually inclement. Although the winter was suitable for excavation work, it was late in the spring before concreting could be started. Up to the end of October about 164 hours, or 7 per cent. of the possible working time had been lost, owing to wet and stormy weather conditions. Nevertheless, a good deal of progress was made. Quarries were opened and developed, a good deal of excavation work was carried out, and a considerable amount of concreting work done. In order to ensure an effective seal against the percolation of water through porous or fissured rock, it was found necessary to carry the 16ft. wide tongue trench to a depth of about 60ft. below the river bed. A considerable length of the trench was excavated to that depth in the early summer, and it is anticipated that the bulk of the remainder will be completed during the coming winter. The first batch of concrete was mixed and deposited in the bottom of one of the counterfort trenches on June 17th by Lieut.-Colonel A. Gadie, the Chairman of the Water Committee. Between that date and August 31st, 25,300 cubic yards of concrete and displacers had been deposited. During the year it was decided by the Water Committee that parliamentary powers should be sought to raise the overflow sill level of the intended dam from 1042.5ft. to 1054.5ft. above Ordnance Datum. The extra height would have the effect of increasing the storage capacity of the reservoir from 1700 million gallons to 2203 million gallons at an additional cost of about £90,000. The number of men employed on the works ranged from about 700 during the winter months to some 800 during the summer.

The Axminster Urban District Council carried out works for improving the water supply of the town by the collection of springs in Bever Batch and the construction of an additional service reservoir of about 240,000 gallons capacity. The Colne Valley Water Board drove a new bore-hole, under powers obtained two years ago, and put in pumps, a new rising main, and softening plant, in order to supply the Exhibition at Wembley. It also let contracts for the construction of covered service reservoirs to contain 8,000,000 gallons. Bexhill lodged a Bill for powers to purchase the undertaking of the local water company. The Stoke-on-Trent Council agreed to join with the Newcastle-under-Lyme and Wolstanton Councils in the purchase of the undertaking of the Staffordshire Potteries Waterworks Company for the sum of £840,000 in cash and the discharge of the debenture stock of the nominal value of £121,450.

During the year good progress was made by Aberdeen with the new intake and intake conduit, and it is hoped to complete them both by the middle of the present year. The new storage reservoir and filter beds were completed and put into service. Work also proceeded satisfactorily on the main and branch conduits, all of which, it is anticipated, will be finished by next autumn. The Airy Hall service reservoir and the new pumping station will be completed by the spring of 1926.

The various works in connection with the raising of the level of Loch Katrine, of which mention has been made in previous Annual Articles, proceeded satisfactorily during the year. The landing stage at Stronachlachar and the new roads communicating therewith, the building up of the dam and sluices at the outlet of the loch, and the raising of the level of the basins admitting water to the two aqueducts leading to the city also progressed very favourably. Towards the end of the year tenders were received for the construction of a new road, about 2 miles long, which, together with some length of existing roadway, which it is not proposed to alter, will result in the creation of a good roadway, as far as the County Council of Perthshire own the road, from the Trossachs to a school known as Strone School, situated nearly 6 miles west of the Trossachs.

The Tees Valley Water Board has in hand, under powers acquired in 1923, the laying of a 24in. main from Grassholme Reservoir to the Lartington filters, and contracts are about to be entered into for the construction of the Nunthorpe service reservoirs and pumping station and machinery required for the Stokesley area within the Board's limits of supply.

The Southend Water Company, in spite of severe opposition, obtained an Act for taking water from the Chelmer and Blackwater rivers. The water is to be sterilised by the super lime process, stored and filtered. The estimated yield is 7,000,000 gallons per day and the scheme will necessitate pumping in two stages.

The scheme for the extension of the Southampton Corporation water supply at a cost of £165,000 passed through all the stages of sanction, though not much work was actually done. The contractors, however, actually commenced the laying of the 36in. and 33in. cast iron main from the Otterbourne reservoir to the town, and a small contract was let at the pumping station. Tenders are to be invited early this year for two engines and pumps, each capable of dealing with 6 million gallons a day; for the sinking of two large borings, 8ft. 6in. diameter in the clear, and also for the buildings to house the machinery. Since by its Act of 1921 the Corporation acquired the undertaking of the South Hants Water Company, there has been a considerable and steady increase in the demand for water both for domestic and trade supplies, necessitating the laying of several miles of additional trunk mains.

Early in the year Torquay applied for sanction to borrow rather more than £50,000 for improvements to its water supply. Axbridge and Penrith both have schemes in hand which are estimated to cost approximately half that amount. Nottingham decided to build a service reservoir to contain 3½ million gallons. Particulars of the progress made with the new works for Hull are given in another column.

The Muggleswick tunnel, through which water will be conveyed from the Waskerley reservoir of the Durham County Water Board into the Smiddy Shaw Reservoir, made good progress and is likely to be completed in the late summer of this year, when the existing pumping station at Waskerley reservoir is to be abandoned, with, it is estimated, a saving of some £1500 per annum in pumping charges.

The following have undertakings of various kinds in hand, the approximate estimated expenditure being given in each case:—Girvan, £30,000; Wolverhampton, £23,000; Catherington, £22,500; Uttoxeter, £27,300; Norwich, £20,000; Lochgelly, £20,800; Claycross, £20,000; Doncaster and Tickhill, £89,000; Darlington, £45,000; Northwich, £42,000; Nottingham, £123,000; Worthing, £37,600; Salford, £15,000; Steyning West, £24,000; Swansea, £20,000; Brighton, £100,000; Carlisle, £70,000; Longton, £22,200; and Goole, £22,000. The Stirlingshire and Falkirk Water Board completed the Loch Coulter extension in the Carron Bridge district of Stirlingshire at a cost of £80,000 and is constructing additional filters at a cost of £35,000.

The Sennar Dam on the Blue Nile.

Excellent progress was made with the construction of the Sennar Dam on the Blue Nile, which is to provide water for the Gezira irrigation project. The eastern portion of the dam was taken up to a height of + 410.23 m., which is high enough to enable the work to be taken up to full height during the present season without the necessity of constructing sudds or cofferdams. It will only be necessary to construct small sudds upstream and downstream of an opening 130 m. wide, which was left in the western channel for the diversion of the river during last season's operations. It is anticipated that during the present season, which commenced at the end of October and will terminate at the beginning of next July, the whole of the superstructure will be built and the sluices got into position. Concurrently with the building of the dam work on the formation of the irrigation canals and channels in the Gezira proceeded satisfactorily. A view of the downstream face of the eastern portion was given in the Supplement which accompanied our issue of January 2nd.

Singapore.

One of the most interesting water supply schemes, which are being carried out in the East, is that of the Municipality of Singapore, which was outlined in our issue of January 19th, 1923. The scheme has been divided into four sections:—(1) The Gunong Pulai Dam and Filters; (2) the length of the pipe line in that State of Johore; (3) the length of the pipe line in Singapore Island; (4) the service reservoir at Fort Canning. The contracts for the steel pipes for both sections of the pipe line were let during the year to Stewarts and Lloyds, Limited. The pipes, which are of welded steel 33in., 36in. and 39in. diameter, with socket joints, are being manufactured in this country, and are nested one inside the other to reduce freight charges. A depôt has been erected at Holland-road—which is in proximity to the railway and about 5 miles from Singapore—and to it the pipes for the Singapore Island section are being delivered. At it the pipes are lined with mortar ½in. thick under a subcontract let to the Hume Pipe Company. They are then wrapped externally with tarred Hessian, and before being laid in the trench they receive two coats of bituminous paint internally. Analyses of the soil taken at intervals along the pipe line showed that the jungle soils contain acids liable to corrode the steel, and where laid through the jungle the pipes will be surrounded with concrete, the Hessian wrapping being omitted. There are several marshes to cross, where the pipes will be laid above ground supported on pedestals and piles where necessary. Analyses of the soil through the rubber estates proved that it was either neutral or slightly alkaline, and reliance will there be placed on the Hessian wrapping for protection from corrosion. About one-third of the pipes for the Singapore Island section were delivered during the year, and a pipe-laying contract was let to Messrs. Fogden and Brisbane, who began the work of laying of the pipes. With regard to the Johore section of the pipe line, the pipes will be delivered at a jetty in the Scudai Creek, where a depôt similar to that at Holland-road already described will be constructed. The jetty is under construction, and should be completed by April, when the first deliveries for the Johore section pipes will arrive. The Municipal Commissioners have decided to carry out the dam by administration. The district in which the dam will be situated is a somewhat unhealthy one, and the work at present proceeding comprises the anti-malarial measures which are being carried out under the superintendence of Dr. Hunter, the medical officer of health of Singapore, the erection of coolie lines and temporary buildings, the provision of the temporary water supply, and the access road. A considerable amount of excavation was carried out to lay bare the granite underlying the foundations of the dam, and a start was made to widen and deepen the trench for the permanent foundations. The plans for the Fort Canning Reservoir near Singapore Town are being prepared, and it is expected that a start will be made on this work in about eighteen months' time.

High Head Pumping Plant at Simla.

An interesting plant for supplementing the previously existing water supply of Simla was put into service during the year. As we propose to give, at an early date, full particulars of this undertaking, all that need be said at the present time is that the new source tapped is situated some 8 miles away from the station and no less than 4000ft. below the reservoir at Sanjouli, from which Simla is supplied. The pumps employed are of the four ram type, and they are driven by electric motors. The total head against which they deliver is 4200ft., which is believed to be a record lift for a waterworks plant. It is intended eventually to instal six units, each of which is designed to lift 580 gallons per minute, or at the rate of 835,200 gallons per day. At present only two of the units have been put to work, and with them some extraordinarily good efficiencies have been obtained.

Water Supply to an Indian Coalfield.

The most important coalfield in India is that known as the Jharia, which is about 160 miles from Calcutta, and which yields some 8,000,000 tons of coal per annum. Before it received its new supply in the middle of the year, the district, which contains a seasonally fluctuating population amounting sometimes to some 200,000, had to rely on tanks and wells, and to some extent on water pumped from the mines and filtered. The situation was by no means satisfactory, for the sources of supply were certainly not above suspicion, and there were occasionally epidemics of cholera, &c. As long ago as 1909 the Indian Mining Association decided that a supply from some uncontaminated source was of vital necessity. The first proposal was that it should be obtained from the river Damodar, which runs through the district, but eventually it was decided that a dam should be built on a site in a range of hills to the north-westward of the coalfield, that an aqueduct should be constructed, and a system of distribution mains laid. The dam, which impounds some 1,150,000,000 gallons of water, was completed and filled during the year, but the full system of distribution mains is not yet in service. The total daily yield when the scheme is completed will be over 4,000,000 gallons per day.

Hong Kong.

During the year pumping plant was put into regular work for the purpose of supplementing the supply to the Peak District. It consists of a triple-expansion horizontal engine, with cylinders 15½in., 23in., and 34in., and a stroke of 24in., coupled direct to high lift pumps 5½in. diameter and low lift pumps 8½in. diameter. The pumps deliver to two services, the low level raising 550 gallons per minute to a height of 550ft., and the high level 200 gallons per minute to the Peak, a height of 1625ft. The plant was supplied by Tangye, Limited and erected in the Colony, together with the boiler and all the auxiliary plant, by the Public Works Department.

The guaranteed steam consumption is 14¾ lb. per pump horse-power, calculated on 100 deg. of superheat, and the mechanical efficiency of the whole is 85 per cent.

Work is in hand to increase the capacity of the Tai-Tam-Tuk pumping station, which was described in the issue of THE ENGINEER for February 18th, 1921. The existing station is to be extended and an additional pumping set on lines similar to those of the previous sets, but differing in essential details, is to be installed. A vertical engine, with cylinders 18in., 31in., and 50in. in diameter by 36in. stroke, fitted with balanced double-beat drop valves with trip gear, is to be coupled direct to pumps, with plungers 15½in. and 36in., of specially chilled cast iron. The capacity of the pumps is to be 3¼ million gallons working against a head of 400ft. The plant has been constructed by Worthington-Simpson, Limited, at Newark, and is in process of being transported to the Colony. The guaranteed steam consumption, including all jackets, receivers, drainage, &c., is 11.5 lb. per pump horse-power, and the mechanical efficiency 90 per cent. In ordinary daily working, however,

all the jacket and other drains will be in closed circulation with the boiler, and the consumption of steam is guaranteed 11 lb. per pump horse-power.

During the year the P.W.D. has begun work on a new scheme for impounding water on the Kowloon, or mainland, side of Hong Kong Harbour. The water of certain streams will be impounded and brought down to Kowloon and eventually carried across the harbour to Hong Kong, and there connected to the existing system to augment the water supply as required.

France.

During the past year more than usual activity was displayed in carrying out schemes for increasing the water supply of Paris. The situation had become so serious that the putting in hand of the projected undertakings could be no longer delayed. The population had increased enormously without any provision having been made for bringing additional supplies of water to the city, and the fear that trouble might arise with the old Vanne and Dhuis conduits made it absolutely imperative to push forward new schemes which had remained in abeyance owing to the precarious state of the municipal finances. Since the war nothing had been done except to start upon the works for bringing water from the Voulzie source. That has now been terminated, and the Municipal Council is asking for powers to raise a further loan that will enable it to put in hand a programme which will be completed by 1930. The supply is to be supplemented from the Durteint and the Dragon, and then it is proposed to tap the sources of Fontaine-sous-Jouy. The Council did not wait to complete its financial arrangements before starting upon this programme, and a good deal was done during the year in laying down conduits, constructing syphons and installing centrifugal pumping plants driven by internal combustion engines. The conduits are nearly all cast iron. It is also intended to extend the filtering beds at Ivry, which, in two years' time, will increase the supply by 200,000 cubic metres a day. At present the Paris supply consists of half spring and half filtered water, and it has frequently to be supplemented with sterilised river water. During the war the sterilisation was effected by a small addition of eau de Javal, which is a chloride employed extensively for bleaching linen, and as the method was found to be quite satisfactory it has now become general. When the present programme is completed, all the available supplies of spring water will have been utilised, and it is then proposed to bring water from vast reservoirs or lakes, which may be constructed in the upper part of the Seine Valley, as a means of regulating the water level and preventing floods. The only other important scheme in France is the one still under discussion for supplying water to Marseilles from a source in the Alps. The original plan has been modified through the necessity of providing for the requirements of other towns in the Bouches-du-Rhône, and the scheme has not yet left the preliminary stage.

Other Works Abroad.

In the early part of the year water was let into the 18 miles long Shandaken Tunnel, which forms part of the new aqueduct which is being constructed to convey additional supplies of water to New York from the Catskill Mountains. The scheme of the Corporation of Calcutta for the extension of the Pulta Waterworks will involve the expenditure of upwards of 846,300 rupees. Its scope was extended during the year to include six additional filters and a larger settling tank. Sydney (N.S.W.) has in contemplation a scheme of waterworks extension which will cost nearly a quarter of a million sterling. The authorities at Athens instituted an international competition for the design, construction, upkeep and exploitation of works for the supply of water for Athens and the Piræus. After boring operations, extending over two years and four months, the tunnel which is to convey a new water supply to Wellington, N.Z., was successfully pierced at the end of February. The tunnel had to penetrate 2 miles of rock through a range of hills 2500ft. high. The work was carried out by co-operative labour, and there were no accidents throughout the whole period. It is proposed to use the waters of Lake Briva, in Japan, for affording a potable supply to Osaka, Kobe and Sakai. The scheme includes the construction of an aqueduct capable of conveying nearly 350 million gallons of water per day, and a feature of the proposal is that the water will first be employed for the generation of electricity.

The construction of the Vernon Hooper dam at Shongweni, which is to provide a new water supply for Durban, was pushed on rapidly. The dam will impound the waters of the river Umlass, and will cost about three-quarters of a million sterling. It will block the valley to a depth of 94ft. The dam will be 800ft. in length, 70ft. wide at foundation level, and 10ft. wide at top. A daily supply of 20 million gallons will be provided. The Mexican Government granted a concession for the construction of a large irrigation dam to impound the waters of Lake Santiaguilio and the waters of the Guatimape River. The Rand Water Board decided to proceed with the second unit of its water supply scheme, which will provide a further 5 million gallons a day from the Vaal River, at an estimated cost of £318,000. It is proposed to supply Edmonton (Canada) with water from Pigeon Lake, using the Wizard Lake as a reservoir. The pipe line would be about 29 miles long, and a tunnel 9500ft. long would be needed between the two lakes. The suggested supply is 15 million gallons per day.

The suburban and outer suburban districts of Auckland, New Zealand, are discussing a proposal to convey water from Lake Taupo. At a conference held in the autumn it was agreed that the local bodies interested should form themselves into a Board, and contribute towards the expenses of a report on the scheme. A considerable amount of preliminary work was done in connection with the Dawson Valley, Queensland, irrigation project. The Dawson River is to have built across it a concrete dam, 130ft. high, which will impound over 670,000 million gallons. The municipality of Bethelehem, in the Orange Free State, is seeking permission to construct a dam across the river Jordan, which will impound some 1300 million gallons. An extensive irrigation scheme in the province of Mendoza, in Argentina, was determined upon during the year. It is proposed to irrigate an area of some 40,000 hectares, and the project includes increasing the capacity of the irrigating power of the Atuel, Diamante and Tuyuan rivers, and the extension of the dams on the Uspallata and Mendoza rivers.

The Measurement of Mechanical Vibrations.

By H. A. THOMAS, M.Sc., of the National Physical Laboratory.

IN a former issue of THE ENGINEER a method of measuring small motions by means of an electrical arrangement was described by the author.* Its advantages over other methods of measurement were claimed to be threefold, viz.:—(*a*) Its remarkable sensitivity; (*b*) its accuracy at reasonably high mechanical frequencies; and (*c*) the absence of any disturbing inertia effect due to the application of the apparatus to the body whose movements it was desired to measure.

In view of many developments, experiments and practical applications of the method which have since taken place, the author feels that results and details of the applications will not be without interest.

For the sake of completeness, a little overlapping of the general principle of operation will be necessary, and since the theory can now be given in much greater detail, it will be essential to deal with it at the outset.

The electrical circuit arrangement is now as shown in Fig. 1, from which it will be seen that the thermionic vacuum tube *a* serves to generate electrical high-frequency oscillations in the resonating circuit, consisting of the tapped inductance *b* and the tuning condenser *c*, the connections being those of the well-known Hartley circuit. The circuit *b c* has a natural resonating frequency of about 800,000 cycles per second. The inductance *b* is made in the form of a small coil of about 100 turns of No. 36 S.W.G. insulated copper wire wound into a thin slot about ¾in. diameter.

We have to consider what takes place when a plate of high resistivity metal *p* is brought near to the oscillatory inductance *b*. In Fig. 2 an attempt is made to analyse vectorially the effect of such an introduction.

Let the normal E.M.F. and current in the oscillatory circuit be represented by the vectors E_1 and I_1 respectively in the diagram. At resonance, since the electrical impedance of the circuit is merely that due to the resistance component, the current must be in phase with the applied E.M.F. A flux φ_1 in phase with I_1 will thus operate upon the metallic plate, when introduced into the field, and thus an E.M.F. E_p lagging 90 deg. behind the applied flux will tend to produce eddy currents in the surface of the metallic plate.

The phase and magnitude of the current so set up will depend upon the relative magnitudes of the resistance and reactance components of this eddy current circuit.

Now, it is very difficult to analyse theoretically the method of distribution of such a circulating current in a homogeneous metallic mass, but we can at least definitely state that there will be a mean inductance path dependent chiefly upon the dimensions of the inductance, and this mean path will have a definite effective resistance at the particular frequency. Therefore a current I_p will be produced in the plate lagging by an angle θ from the exciting E.M.F. E_p.

If the metal has a low resistivity, θ will approach the value of 90 deg., and if the metal has a high resistance, I_p will tend to become more and more nearly in phase with E_p. This eddy current will set up a flux φ_p in phase with it, which will act as a back E.M.F. generated in the original oscillatory circuit. Lagging therefore by 90 deg., we shall have a back E.M.F. E_b inserted into the original oscillatory circuit, and since the frequency is still the same, a current I_b will be produced, the ratio $\frac{E_1}{I_1}$ being obviously equal to the ratio $\frac{E_b}{I_b}$. The net E.M.F. and current is therefore reduced from E_1 and I_1 to E and I, and this reduction will be a maximum when θ is small, *i.e.*, when the electrical resistivity of the metal is high.

The effect therefore of introducing this metallic body is to increase the effective resistance of the high frequency circuit, and so to reduce the oscillating E.M.F. across the grid of the triode.

Now let us consider the static $v_g - i_a$ characteristic of the valve, Fig. 3. The normal direct anode current in the non-oscillating condition will be given by I_o, since the grid volts are zero. Now let the maximum applied E.M.F. due to oscillation be V_o impressed on the grid. The anode current will alternate between the values I_1 and I_2, and the mean value will be approximately represented by the mean value I between these two values. The value of I is really dependent upon an integral expression, but we can afford to neglect this fact in a general description.

When the eddy plate is brought near to the oscillatory coil, we have seen that a reduction of applied alternating grid voltage takes place. Let this new reduced voltage have a maximum value of V'. The anode current will now vary between the limits I_3 and I_4, giving a mean value I', which is less than I. Thus the secondary effect of the presence of the plate is to reduce the normal anode current and a curve connecting anode current and linear movement of the plate, such as is shown in Fig. 4, will reveal that over a certain part of the characteristic *x* the anode current change is linear with respect to small movements of the metal plate. The balanced micro-ammeter or galvanometer in Fig. 1 will therefore

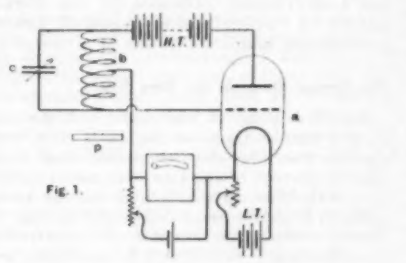


Fig. 1.

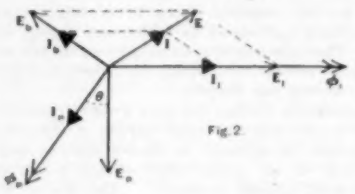


Fig. 2.

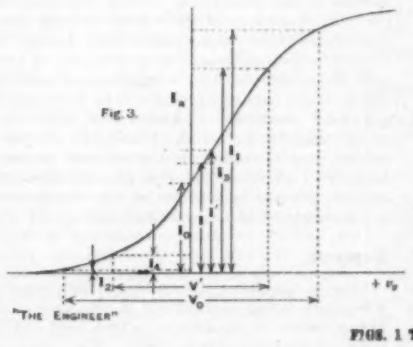


Fig. 3.

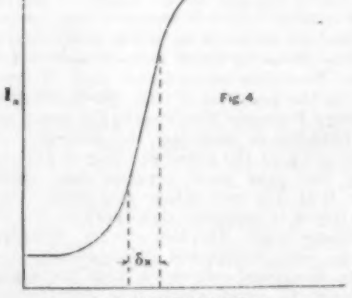


Fig. 4.

FIGS. 1 TO 4

* "Precision Measuring Instrument for Small Motions of Solid Bodies," THE ENGINEER, February 9th, 1923.

record movements of the metal body and great sensitivity can in this way be obtained; 10^{-7}in. is quite easily measurable with an ordinary moving coil galvanometer.

The calibration is purely mechanical, since a definite known shift of the plate or coil will produce a change of current which acts as a reference by which all other observed changes may be compared.

No interference with the natural motion of the observed member is possible, since the electric and magnetic fields are extremely weak.

By using an Einthoven string galvanometer as the recording instrument, vibrations can easily be recorded and photographed, the limiting frequency being imposed by the natural frequency and decrement of the string itself. This can be made very high dependent upon the sensitivity demanded.

The practical application of the method has now to be described for the purpose of recording vibratory strains in steel members.

A simple type of extensometer has been used and is shown in Fig. 5. The two limbs A and B are clamped to the girder or member under test by means of the clamping arrangement, as shown. Each limb is provided with two hardened steel points *a a*, which are forced into the metal. In this way the gauge length will be between the points *a a*.

The two members are originally tied together by the bar *c* and the pins *d*, and thus a definite gauge length is maintained until both parts of the extensometer are firmly clamped to the girder. The pins and bar are then removed.

This extensometer was built entirely for the purpose of measuring the vibrations existing in large girders where its mass is negligible with respect to the girder. In the case of small members, the gear would, of course, be seriously modified.

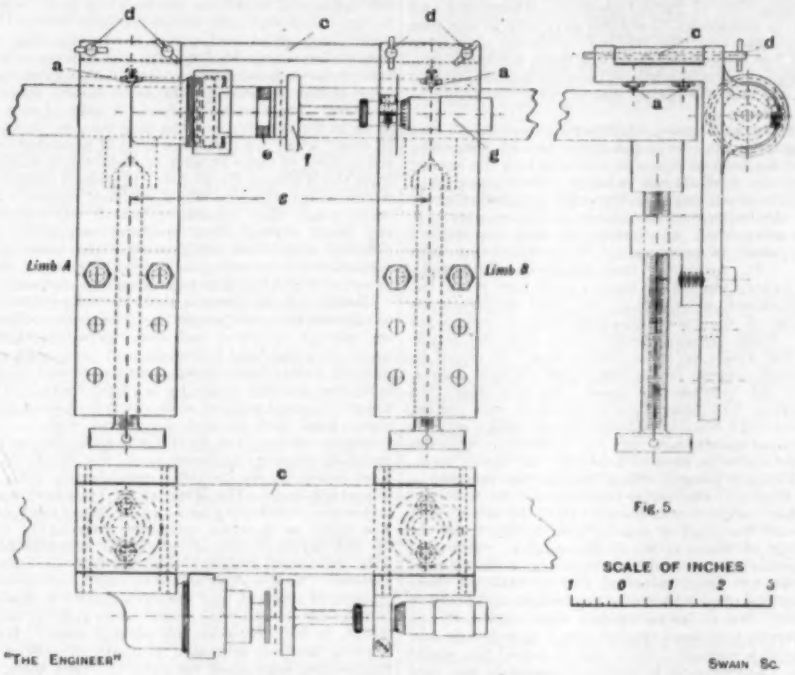


FIG. 5—SIMPLE TYPE OF EXTENSOMETER

The limb A holds the coil *e* and the plate *f* attached to the other limb B can be fed forward by means of the micrometer *g*. In practice, it is found difficult to build a micrometer of sufficient accuracy to move the plate sufficiently small known amounts, and under bad climatic conditions in difficult spots, the reading of such a micrometer becomes exceedingly difficult. For this reason, and for the purpose of greater accuracy, a description will be made of a more elaborate, but much more accurate instrument.

The drawings of this extensometer are shown in Fig. 6. As before, it consists essentially of two quite separate limbs, each in the form of a tripod. Limb A holds the coil C wound on to an ebonite bobbin D clamped by means of the ring E to the main casting. The limb is held to the girder by means of a large clamp fixed between the socket F on the casting, and the underside of the girder.

The limb B is built in the form of a casting similar to limb A, except that the web is cut away at G to allow of the micrometer being freely inserted. The plate H and micrometer form a separate unit, which can be clamped by means of the split collar and nut J firmly to the main limb B.

The details of the micrometer itself are shown in the lower part of the drawing enlarged to twice full size. The plate is affixed to a ground steel stem K, which terminates with a hardened steel spherical surface at L. This stem is capable of movement in the direction of its axis by means of the two ball cages M, holding it in the ground steel tube N. Such a method permits an easy movement and yet a rigid definition of position when the spherical end is hard against any surface. A spring O keeps the stem firmly pressed against a hardened steel wedge P, 1in. long, and having a taper on one in fifty accurately ground. This wedge lies against three spherical hardened surfaces Q, forming part of a back plate R screwed to the main casting S. The wedge is held against a steel ball and micrometer screw U by means of the two springs V.

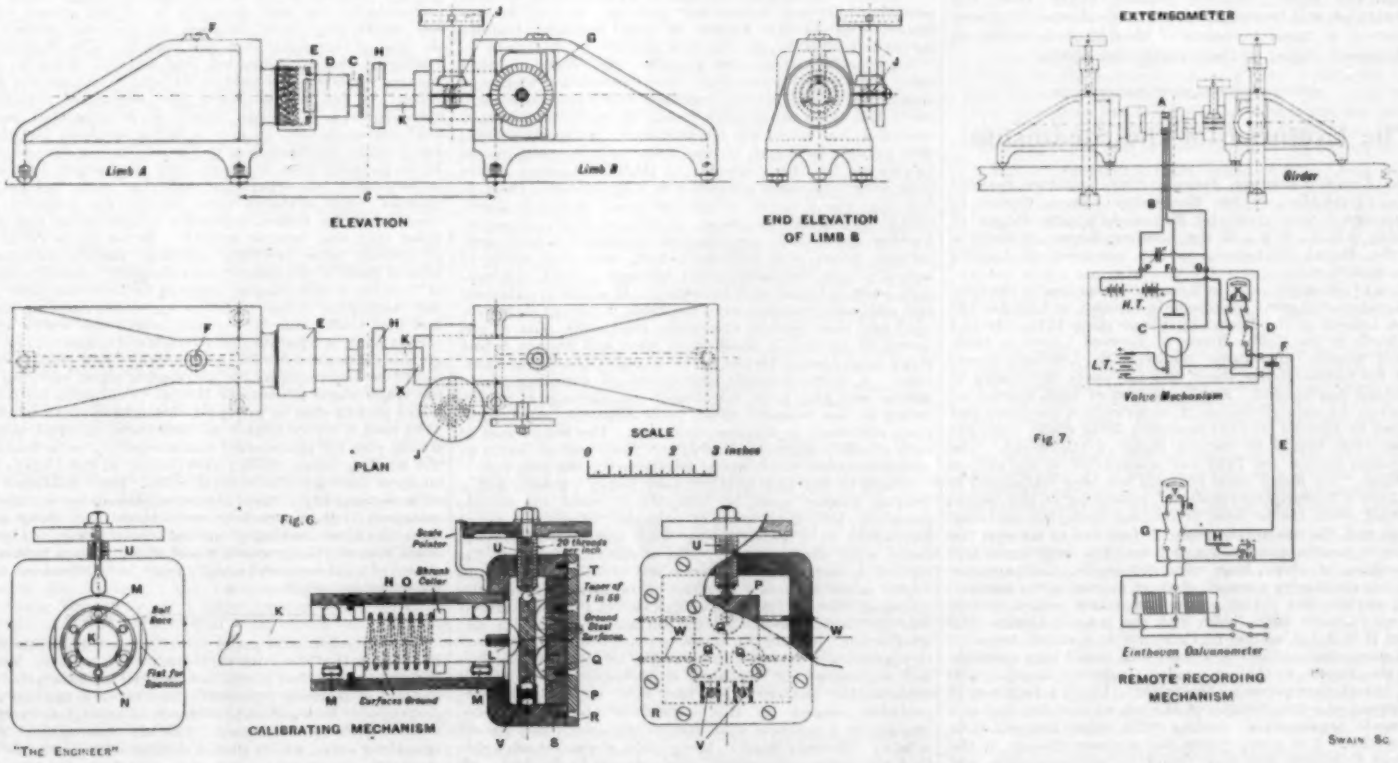
As the micrometer feeds the wedge down, the stem moves forward and with twenty threads per inch on the micrometer, one whole turn represents a motion of 1/1000 inch. With such a coarse thread and such a large angular turn per thousandth of an inch, accuracy of movement is obtained quite easily. The wedge is guided in its movement by the four adjustable screws W. A flat X on the front ground cylinder N provides a means of locking up this part firmly to the main casting.

In assembling the micrometer mechanism, the wedge P, ball T and springs V are first placed in position, and the back plate R is screwed up. The plate axle K, spring O and ball races M are inserted in the tube N, and this unit is then screwed and clamped to the main body of the micrometer S by being pushed through the clamping tube in the main limb B.

The two limbs A and B are then clamped to the girder under test at a definite gauge length of 6in. marked previously to attachment by punch holes. The approximate position of the plate with respect to the coil is adjusted by means of sliding the whole calibrating mechanism and clamping when the correct position for maximum sensitivity on the linear part of the characteristic is obtained.

The general lay-out of the apparatus is illustrated in Fig. 7.

The extensometer is clamped to the girder under test, as shown, and the three leads from the oscillatory coil A are taken to the valve mechanism, consisting of the valve C and its associated low and high-tension batteries. This part of the apparatus is housed in a box which is suspended on rubber cords below the



FIGS. 6 AND 7—ELABORATED EXTENSOMETER AND REMOTE RECORDING MECHANISM

girder, so that no vibrations can affect the valve itself.

The leads B are made as short as possible, and are mechanically rigid and spaced at least 1in. apart, so that no variation in the self-capacity of the circuit can occur. These leads can be wound round thick rubber cord and bound into position. In this way a flexible lead can be used between the extensometer and the valve box. A milli-ammeter X mounted on the side of the box can be inserted by means of the switch D into the anode circuit for the purpose of

obtaining the rough setting of the plate in the magnetic field, preliminary to inserting any delicate recording mechanism. A pair of output leads E shunted by a small fixed condenser F may be taken any distance to the recording mechanism. In practice, a twin lead half a mile long has worked quite satisfactorily.

At the recording end of the apparatus, a micro-ammeter Y is inserted and the normal steady anode current, as read by the milli-ammeter X, is balanced out by the two-volt cell and series resistance H. When the current is approximately zero, the switch G is thrown over and the Einthoven string galvanometer inserted. Any small variation of the gauge length will now be accurately recorded up to frequencies of about 1500 per second, depending on the sensitivity required, and consequently upon the tension of the string.

The final calibration is obtained by moving the plate a known amount and photographing the shift of the string.

Results have been obtained on special test members under load in testing machines, and it has been found that greater accuracy can be obtained than with the usual mechanical and optical extensometers. Photographs of bridge vibrations and experimental vibrating bars have yielded good results, if care is taken to see that all batteries are giving a constant voltage on load. This requires that the "head" be taken off the low-tension batteries—after the battery is charged it should be slowly discharged for an hour or so, in order that the preliminary rapid fall of voltage may take place before the cells are used for lighting the filament and for balancing the anode current. High-tension batteries of the small accumulator type do not suffer so much in this respect, as the load current is small compared with the charging rate

In the case of the girder test work, several oscillating coils attached to their respective extensometers were led to one central measuring instrument, throw-over switches in the high-frequency circuit being employed. It was found that if the three leads from the coil were spaced 1in. apart, no loss of sensitivity was obtained, even when the leads were 30ft. long.

For analysing the transient phenomena occurring when a vibrating bar forced into oscillation at a definite frequency changes to its own natural frequency when the applied force is removed, the method has been found entirely successful. The determination of nodes in vibrating systems can similarly easily be accomplished.

In conclusion, it should be stated that care must be taken to see that the insulation of both the high-frequency leads and the twin cable to the recording instrument is good. Poor insulation gives erratic movements of the recording mechanism. A description of the instrument and its operation is all that is attempted here, but the author hopes that the description will be sufficient to enable those who desire accuracy in measurements of this kind to build an instrument suited to their particular needs.

The Evolution of the Steamship.

ON Tuesday evening, January 20th, a lecture entitled "The Evolution of the Steamship: From Comet to Leviathan," was given by Engineer-Captain Edgar C. Smith, O.B.E., R.N., in the Reading Room of Lloyd's, in the Royal Exchange, to the members of Lloyd's Students' Society.

One of the most important business concerns in the City of London, the great Insurance Institution of Lloyd's, has been housed in the Royal Exchange since 1774. It had its birth in the Coffee House of Edward Lloyd in 1688. Lloyd shortly afterwards removed to Lombard-street, and his Coffee House there was for years the centre of shipping intelligence. Mainly concerned with marine insurance, the various classes of underwriting members and others in Lloyd's in 1921 exceeded 3000, while there are some 1400 agents in various parts of the world. The premium income for 1920 was upwards of thirty million sterling. For many years business has been transacted in "Lloyd's Subscription Rooms," consisting of the underwriting room, the brokers' or reading room, the captains' room and the committee room. Here are to be seen the bulletin boards announcing the arrivals, departures and casualties of ships, huge casualty books, the captains' register containing a record of every master in the mercantile marine, the oldest marine insurance policy extant, dated January 20th, 1680, and the famous Lutine Bell from H.M.S Lutine lost in 1799, which is struck twice on the announcement of the arrival of a vessel long overdue. In the Royal Exchange is also produced *Lloyd's List*, the oldest newspaper in the world. Lloyd's Registry of Shipping was an offshoot of the parent society, but is a separate organisation, dealing with other matters than insurance. For many years the accommodation in the Royal Exchange has been found to be inadequate, and within the next two years Lloyd's will remove to a new and more commodious building now being erected in Leadenhall-street.

In opening his lecture Engineer-Captain Smith expressed his appreciation of the honour of being asked to lecture on such a subject amidst such historic surroundings. The members of his audience were all interested in the steamship, but perhaps they were not aware that the birth of the steam engine coincided with the early days of Lloyd's. Indeed, it was while Lloyd's Coffee House stood in Lombard-street that in 1716 the *London Gazette* published probably the first advertisement of the steam engine. That was ten years before their famous newspaper, *Lloyd's List*, appeared. The advertisement was to the effect that if any one wanted to know about Newcomen's new fire-engine he should come on a Wednesday to the Sword Blade Coffee House in Birchin-lane, which runs from Lombard-street to Cornhill. He might also point out that forty years later James Watt, as a timid apprentice, was learning to make sextants in Morgan's shop in Finch-lane, just behind the Royal Exchange.

With the help of many lantern slides Captain Smith then proceeded to show how the little Comet of 1812 was followed by such vessels as the James Watt of 1822, Brunel's Great Western and Great Britain, the Britannia and Scotia, and such record breakers as the Arizona, Servia, City of Rome, Etruria, City of Paris, Campania, Mauretania and Aquitania. It was shown how wood gave way to iron and iron to steel, and also how the old cumbrous side lever engines and flue boilers had been displaced by compound, triple-expansion and quadruple-expansion engines, and by the steam turbines associated mainly with the name of Sir Charles Parsons.

In concluding his lecture, Engineer-Captain Smith said that having spent his life in the Navy he had now come to anchor at the Science Museum, where he had the honour of becoming the first official lecturer. That great institution, he submitted, ought to have the support of every shipowner, shipbuilder and engineer in the country. It was much more than a museum, it was the nation's permanent palace of engineering. Its collections were unrivalled. If, however, the members of Lloyd's Students' Society visited it they would find it in the same predicament as Lloyd's. It had outgrown its house. Some of the collections had been in cellars for ten years. Those present might have seen the recent articles in *The Times* on the overcrowding. If would be no use Falstaff coming to see the Britannia and Scotia. He couldn't get between the cases. He was afraid the Science Museum had been the Cinderella of such places. As compared with similar institutions one might say the Science Museum showed how men had made their fortunes, while the Art Galleries showed how they had spent them. It was Sir Richard Tangye, whose first success was due to the Great Eastern, who gave Birmingham its beautiful picture gallery, while it was Samson Fox, the inventor of the corrugated flue used in marine boilers, who built the Royal College of Music at South Kensington. The steel maker Bessemer, the electrician Hughes, and the chemist Mond had all left large fortunes, and he believed there were still wealthy shipbuilders and shipowners and possibly underwriters. But so far as legacies were concerned, the Science Museum had been treated like a spendthrift and cut off without a shilling. Some day he hoped this would be rectified. Engineering at South Kensington was now well housed, but shipping was not. What was wanted next was a National Gallery of Ships and Shipping worthy of the greatest port in the world, the nation itself and our glorious heritage of the sea. Finally, he would remind the members of their Society that if they were ever in need of technical information they would probably get more assistance at the Science Museum than anywhere else. Its technical library was the finest in the country.

Roads in Devonshire.

"ROADS" formed the subject of an interesting address recently delivered before the members of the Exeter Rotary Club by Mr. Andrew Warren, Southern District surveyor to the Devon County Council.

After some preliminary remarks, Mr. Warren stated that, with some exceptions, the Devonshire highways were sadly out of date as regarded width and could only be looked upon as country lanes, no doubt exceedingly beautiful, but extremely inconvenient. No modern roadway should, he urged, be less than 30ft. in width, so as to provide for three streams of traffic. Another defect from which the roads suffered was their excessive camber, but that was a defect which was being gradually eliminated, and would, he hoped, shortly be quite overcome. Further, some of the surfaces were at present full of corrugations, waves and potholes, which were due either to lack of proper foundations and drainage, to lack of lateral support or to lack of skill in making. If proper foundations and adequate drainage were desirable in former days, the need had now become absolutely imperative, and it was bound to be only a question of time and finance before every main road in Devon would be reconstructed on those lines. A more scientific treatment of surfacing, more lasting and also more convenient for mechanical traffic, owing to less tractive effort being required, must come more and more to the fore in future. The initial cost of such a policy might be heavy, but there was no doubt as to the economy which would be effected in the long run.

Roads to-day had to stand very heavy stresses, and a wearing surface must be provided to resist the thrust, pounding, &c., of all kinds of vehicles. They often heard mentioned in a general way that unsurfaced concrete roads were unsatisfactory, and a careful study of the reports on such roads in America and in this country would reveal many failures. It must be remembered that the pounding effect of traffic on a rigid slab of Portland cement concrete rapidly weakened the surface to a point of disintegration. If traffic on concrete roads could be restricted to pneumatic-tired vehicles all might be well. Expansion and contraction of the steel reinforcement also caused considerable anxiety. He had seen scores of cracks, probably caused by this expansion and contraction, develop in a concrete road before any traffic had passed over it. Having regard to these facts, it seemed advisable that the surface of concrete roads should be finished with a shock-absorbing carpet to take the traffic impact and thus prevent disintegration. The jar and pound of the solid-tired motor wagon, steel-tired traction engine, or heavy passenger omnibus, were liable to wreck the non-elastic and non-shock-absorbing pavements, but these protective carpets would conserve the life of the road base or foundation for an indefinite period.

Turning to what was being done at the present time to solve the problem of road maintenance in Devon, Mr. Warren observed that many motorists laboured under the impression that far more was paid in motor taxes than was ever spent on the roads. As a matter of fact, only about one-quarter of the annual expenditure on road maintenance was contributed by motorists in the form of taxes, the remaining portion having to be borne by the local ratepayers. He thought, however, that motorists had a legitimate cause for complaint when they compared the amounts of tax paid, for example, by a heavy traction engine and by a car. Heavy steel-tired vehicles did more damage to a road in one journey than an ordinary touring car did in twelve months. A traction engine with an unloaded weight exceeding 12 tons paid £30 per annum tax; while a medium-powered touring car had to pay from £20 to £25, a comparison which was quite ridiculous.

An enormous burden was thrown upon the local ratepayers in respect of the unclassified roads in Devon, towards the upkeep of which no Government grant was received by the urban and rural authorities concerned. The traffic which used these unclassified roads was often of a very heavy character. In a county like Devon, which was so full of natural attractions, omnibus services and char-à-banc traffic to rural beauty spots caused enormous wear and tear. There were thousands of miles of such roads and lanes in the county, and the time was, he thought, bound to come when a substantial annual contribution towards the upkeep of some at least of these roads would be made from the National Exchequer. It seemed certain that they would eventually become a national charge. Increasing traffic made that imperative, and it was becoming more and more evident that the local ratepayers could not possibly meet their obligations if the roads were to be maintained in the requisite state of efficiency. He was not, however, in favour of nationalising the highways.

Continuing, the lecturer said that it had now come to be recognised by most people that the modern road must be the nearest, quickest and safest route to one's destination. It must have a smooth and contoured surface, be of good width, have useful open fences and be in keeping with the demand made by modern traffic. The Devon County Council realised that a policy of reconstruction on those lines had become necessary, and reconstruction schemes costing over £1,000,000 were the outcome of a decision properly to reconstruct the whole of the principal roads in the county, commencing with the most important ones. The Ministry of Transport was in some instances contributing as much as 75 per cent. of the cost. The roads in question would be thoroughly modernised by the laying down of reinforced concrete foundations with adequate drainage, and asphalt or other modern surfaces. New bridges would be built, and certain existing structures widened and strengthened to withstand safely the stresses set up by the traffic. The width of these bridges would be 50ft. between the parapet walls. Many of the existing bridges, although no doubt objects of beauty in themselves, were much too narrow. They were, moreover, built at awkward angles with steep approaches, and were generally incapable of supporting the heavy weights now passing over them. In the widening and strengthening of them, every care would be taken that the local surroundings should be conformed to as far as possible.

The very serious problem of slippery roads had cost him a good deal of anxiety. That part of the problem was particularly important to the agriculturists and the market gardeners who had to bring their produce to the towns, and naturally expected safe routes over which to travel. Various bituminous compounds now on the market formed an excellent road surface for motorists, but were not quite suitable for horse traffic, and up to the present a surface to suit both classes of traffic had not been constructed. A very serious contributory cause of slipperiness was undoubtedly the large quantity of oil and grease which was continually being dropped on the road surface by the tens of thousands of motor vehicles. The Ministry of Transport had experimented, and was still doing so with various surfacing methods to try and overcome the difficulty. It had recommended that additional granite or other suitable chippings should be incorporated in the final surfacing coat to give a better foothold for horses and a more satisfactory grip for the rubber tires of cars. Those methods were, however, only satisfactory for a week or two, and his experience was that with fast-moving vehicles, such surfaces very quickly got polished and treacherous for horses, especially if their shoes had worn down thin and become smooth. As far as he could see at present, after carefully watching various surfaces in several parts of the country and adopting various methods of forming a non-slippery surface himself, the only safe and reasonable course to follow on routes carrying heavy and fast traffic was to provide, where the width would permit of it, a separate gravel track for horses on one side of the carriageway. He was hoping that that method would be embraced as far as possible when carrying out the trunk roads schemes in Devon. Footpaths for pedestrians should also be provided throughout these schemes.

In such a lovely county as theirs was, he must make a strong plea for the charms and attraction to be found in the winding lanes, up-hill viewpoints, in the valleys and on their incomparable coastal roads. Easy gradients and wide carriageways, were, of course, demanded by modern transport, but in creating such roads something more than the mere making of racing tracks must be kept in mind, and anything which would within reason retain the charm of their beautiful county must be followed out in all improvement schemes.

IN the course of a paper read before the Birmingham Branch of the Institute of British Foundrymen, Mr. D. Wilkinson said that it was not easy to lay down the best method of securing pyrometric control of annealing temperatures. A radiation pyrometer, he said, gives excellent results with some furnaces, but the atmosphere of an annealing oven, which should consist of a slowly-moving smoky flame, interferes so much with the correct focus of the instrument upon the pans that low temperatures are frequently registered by it. If this type of instrument be adopted, it is usual to insert a closed fireclay tube through the wall of the oven and to focus the pyrometer upon the closed end of this tube. This cuts out the smoky flame, and when allowance is made for the lag in rise and fall of temperature, due to the tube, very reliable results may be obtained. If a thermo-couple placed inside the oven is used it is necessary to guard against registering a fluctuating flame temperature instead of the true temperature of the pans. The only satisfactory position for a thermo-couple is inside one of the pans, where it will register the actual temperature of the material undergoing treatment. But fixing it in this position is rather troublesome, and frequent renewals are usually required.

Railway Matters.

IT is reported that during the gale of the night of the 13th–14th inst., some of the steel signal arms at Llandudno Junction and Colwyn Bay were bent almost through a right angle by the force of the wind.

ONE of the passengers injured in the Lytham derailment of November 3rd last died, as a consequence of the consequent shock, last week. That made the fifteenth death—fourteen passengers and the driver.

SOME few minutes in running are now saved on the Great Western trains between Paddington and Penzance, Paddington and Fishguard, and Shrewsbury and Newton Abbott, and *vice versâ*, by the engines running throughout, the enginemen only being changed *en route*.

IT is announced that Mr. W. J. Smith has been appointed superintendent of works (L.M.S.) for Derby, Crewe, Stoke and Plaistow, in place of Mr. E. J. H. Lemon, who has become divisional carriage and wagon superintendent (L.M.S.) at Newton Heath and Earlestown.

MANY novel mechanical inventions have finally found their way into the hands of Thos. W. Ward, Limited, of Sheffield, whose speciality is ship and works dismantling. They have now purchased for dismantling the Listowel mono railway, which is the only railway of its kind. The railway is 10 miles long, and it worked continuously from 1887 until October last year.

THE construction in steel of the new restaurant cars on the London, Midland and Scottish Railway is a concession to the objection of those travellers who fear that after an accident fire may result from escaping gas. Steel is much more difficult to fabricate than wood and tends to make the carriages noisy and colder in winter and warmer in summer than timber-built vehicles, while their behaviour in collisions has not yet been proved to be better than wood. But in time steel construction may be found to be cheaper than building in teak.

THE parties concerned in the sale of automatic train control apparatus in the United States have organised an Amalgamated Train Control Sales Corporation. The intention is not to be antagonistic to the railways, but, on the contrary, to help them. They have been asked to appoint a board of engineers to meet with a board of engineers representing the train control companies in an effort to work out, by combination of the various patents, a device which will meet the requirements of the railways and of the Inter-State Commerce Commission.

THE perils and difficulties of railway working in foggy weather were painfully revealed in an inquest held last Saturday on a driver killed at Hornsey during the dense fog on the night of the 15th inst. A signalman reported to the station foreman that an engine was in the section and was delaying other trains. The foreman went in search of the engine, and had to feel his way by the rails. He discovered it by bumping into it, and the fireman then told him that the driver had got down to see where they were and had not returned. Having dispatched the engine forward, the foreman searched for the driver and found that he had been run over and killed.

THE Castleton "cut-off" of the New York Central is in many respects a very interesting work. Its main purpose was to avoid going through Albany and over a route which formed one of the first pieces of railway in America. The gradients are bad, there are several drawbridges over the river Hudson, and there is dense traffic. The new route, which was opened on November 20th, crosses the Hudson 12 miles below Albany by a fixed bridge 135ft. above water with two main spans of 600ft. and 400ft. each. The cut-off necessitated 28 miles of new construction, and the total cost was 25 million dollars. The name of the last president of the company has been given to the bridge, which is to be known as the Alfred H. Smith Memorial Bridge.

DURING a dense fog on the morning of October 14th a light engine arrived on the up line at Hammerton-street Junction, Bradford, to cross into the engine shed sidings. The latter movement could not be made, owing to trains and engines passing on the down line. Fifteen minutes later an up passenger train was signalled, and by then the signalman had forgotten the light engine. A collision, as to which Major Hall has recently reported, resulted. The driver of the light engine is blamed for not more promptly sending his fireman to the box in accordance with Rule 55, and the signalman is blamed for forgetting the light engine, and, in particular, for not using the lever collar provided to act as a reminder in such cases. Track circuit would prevent similar mischances, and is recommended.

TENDERS amounting in all to £231,000 have now been accepted by the Underground Company for the sub-surface portions of the four stations on the Clapham-Tooting section of the Morden extension. Two of the new stations—Balham and Trinity-road—will be entirely below the surface; the others—Nightingale-lane and Tooting Broadway—will have booking halls at ground level. All will be equipped with escalators. Excellent progress is being made with the driving of the new 4¼-mile long tunnels between Clapham Common and Mertongrove, where the line will emerge to the surface. The rotary excavators employed are steadily pushing their way along, and each week sees a matter of 1400ft. of brand new tunnel completed. The company expects to open the line for traffic in December next.

THE Department of Tolima Government, Colombia, has entered into a contract for the construction of an electric tramway, 35 kiloms. in length, estimated to cost 700,000 pesos. The line will connect the towns of San Lorenzo and El Líbano, both of which are important commercial centres for the coffee-producing districts. Surveys have been commenced and plans are to be ready for Government approval before the end of March. A contract has also been entered into between the Antióquia Railway and a foreign engineering firm for the extension of the Amagá Railway from El Pedrero to the Cañoa River. In this department, where considerable railway development is planned, the Ministry of Public Works has appointed a Technical Railway Commission to survey the route for an extension of the Popayán–Cartegena line, and prepare an estimate of the cost.

Notes and Memoranda.

IT is suggested, in the *S.A. Mining and Engineering Journal*, that the Bwana M'Kubwa copper mines, on the Congo-Rhodesia borderland, may soon become the most important of the copper-producing districts of the Empire.

THE output of the Darlington electricity undertaking for the year ended March 30th, 1924, was 13¼ million kilowatt-hours, compared with 9¼ million in the previous year. Working cost fell from 0.70d. to 0.56d. per kilowatt-hour. It is stated that only four towns are producing at a lower figure, and each has a larger output and better load factor than Darlington. The revenue increased from £54,247 to £65,277.

IN the account of the Livingstone film Expedition to Central Africa, which appeared in the *Daily Telegraph*, it was stated that the Chauncy Maples, a lake steamer on Nyassa, is in as good condition now as she was when first commissioned thirty years ago. She is of about 250 tons gross measurement, was transported to the lake in some 4400 separate pieces, and cost, before finally taking the water, £16,000. She has, however, it is said, paid for herself many times over.

BOLD claims are made for a new invention, by a young Frenchman named Verdan, designed to overcome atmospheric and other interruptions in the transmission of wireless telegraph messages. According to reports the apparatus transmits messages by a system of printed letters. Practical experiments are soon to be made with the new appliance between Nice and Ajaccio, Corsica, and it is hoped that, as a result, the cable between France and that island may be dispensed with.

WE learn from the *Electrical Review* that Post Office engineers are inquiring into the allegations that the Government radio-telgraph station at Northolt is responsible for the interference which has occurred of late with broadcast reception from 2 LO and the other British home stations. Post Office experts have contended that Northolt is not the offending station, but both professionals and amateurs have made tests which suggest that their allegations are well founded, and they have convinced the Post Office that a further inquiry is justified.

ACCORDING to the reports presented by the Prussian Chambers of Commerce, prices in the electrical industry increased in December, but the hoped-for revival in the course of business was only partly realised. Orders for large installations were only placed in cases where the electricity works or tramways had available liquid funds resulting from the surpluses on working or where they were enjoying favourable tariffs. Business in electrical equipment for main lines of railways and tramways increased, as also did transactions in light, power, and telephone and telegraph cables and insulated wires, both in Germany and for export.

A PAPER (No. 6) has just been published by the Safety in Mines Research Board on the subject of the support of underground workings in the South Wales coalfield. It consists of a report by a committee appointed to investigate methods of reducing the number of accidents caused by falls of ground in coal mines—the cause at present of practically half the total number of fatal accidents. The committee is making a study of timbering practice in certain coalfields. The present report deals with South Wales only, but many of the suggestions made in it apply equally to other coalfields. The report is brief, and may be purchased (price 2d. post free) through any bookseller or directly from H.M. Stationery Office.

THE authorities at Scotland Yard are reported to be well satisfied with the progress that has been made generally in the utilisation of wireless for tracking criminals. The greatest strides have been made in the equipment attached to motor vans. Seven covered vans are now used daily, and the experiments carried out by Major Vitty and Mr. G. A. H. Wootton, who are in charge of the engineering branch at Scotland Yard, have resulted in the use of rejector circuits. Communication with Scotland Yard is established while on the run with ease and rapidity, and long-distance tests have also proved satisfactory. Four of the vans have invisible aerials, the wires lying flat along the roof, but in the latest the aerial consists of five wires mounted upon adjustable arms attached to the roof. The messages sent from and received by the vans are all coded.

IN a short article on gas engine breakdowns in *Vulcan*, it is pointed out that too much importance cannot be attached to the careful treatment of connecting-rod bolts, both in tightoning, to insure that the working stresses are equally shared, and also in periodically changing or annealing them. Where bolts are fitted at the gudgeon end it is necessary that they should receive as much care and attention as those at the crank end, as the stresses they have to bear are equally great. Generally speaking, bolts at the crank end are more accessible than those at the gudgeon end, and this probably accounts for the latter being often neglected. The working stresses are enormously increased if the bolts are not equally tightened, as then one of the bolts has the tightening stress applied at a leverage in conjunction with a bending action that makes failure almost inevitable.

IT is reported by the National Federation of Iron and Steel Manufacturers that the production of pig iron in December amounted to 580,300 tons, compared with 583,500 tons in November. The furnaces in blast at the end of December numbered 167, a net decrease of 6 since the beginning of the month, 2 furnaces having been blown in and 8 damped down or blown out. The production included 198,500 tons of hematite, 163,400 tons of basic, 158,200 tons of foundry, and 33,500 tons of forge pig iron. The output of steel ingots and castings amounted to 551,000 tons, compared with 674,900 tons in November, and 678,500 tons in October, the decrease being mainly due to the Christmas holidays, and end of the year stocktaking. The December output brings the production of pig iron for 1924 to 7,318,900 tons and of steel to 8,221,100 tons, compared with 7,440,500 tons and 8,481,800 tons respectively in 1923, and 10,260,300 tons and 7,663,900 tons in 1913.

Miscellanea.

IT has been decided to form a Rubber Research Institution in Malaya.

IT is proposed to put up a new chemical works on the banks of the Tyne, at a cost of some £300,000.

IT is intended to supersede the electric tramway system in Singapore by a service of trolley omnibuses.

IT is reported that two new rotor ships, each of 1500 tons, have been ordered from Herr Flettner.

A FACTORY has just been put up near Melbourne, Australia, for producing 50 tons of fibre a week from the bark of local trees.

IT is said that the Government of the Netherlands East Indies proposes to develop a gutta-percha estate on the east coast of Sumatra.

THE seaplanes which are to be built for the Dutch Government by the Fairey Aviation Company will be fitted with 450 horse-power Napier Lion engines.

WHILE making excavations under the market-place at Ilkeston, says the *Birmingham Post*, contractors have struck two seams of coal, 4ft. 6in. and 3ft. thick respectively.

IT is proposed to put up a large plant for the electrical production of cyanide in Mysore. The power required will be taken from the Sivasamudram plant, which will then be on the point of overload.

THE most important of the works at Karachi, India, now in progress, is that involved in connection with the new water supply, which will involve the laying of over 16 miles of pipe line and the expenditure of some thirty lakhs of rupees.

MR. H. KERR THOMAS has been elected President of the Institution of Automobile Engineers for the session 1925–6, the four Vice-presidents for that session being Major E. G. Beaumont, Mr. A. E. Berriman, Mr. L. H. Hounsfield, and Major Charles Wheeler.

A VALUABLE new seam of coal has been struck at Trowell Moor, in the Erewash Valley, according to the *Birmingham Post*. It is 150 yards below the Kilburn seam, and is declared to be an Alton seam, or Halifax soft, as it is called in Yorkshire.

IT is understood that the Egyptian base for the airship service to India will be fixed at Ismailia, on Lake Timsah, about halfway through the Suez Canal. Already an aeroplane landing ground exists there, and to accommodate the airships a mooring mast will be erected and a gas plant put down.

THE Flintshire County Council has accepted the tender of Sir William Arrol and Co. for the construction of a new bridge over the Dee at Queensferry. The bridge will be of three spans, the middle one being made to open for river traffic. The length will be about 372ft., without approaches.

ALTHOUGH the project of setting up a phosphorus factory at Fredrickstad, Norway, has been abandoned for the time being, the *Chemical Trade Journal* suggests that the manufacture of metallic sodium, together with that of red phosphorus, on a limited scale, will be taken up in the near future.

THE Manchester Ship Canal Company has accepted a tender for the construction, at a cost of £300,000, of two new transit sheds at Trafford Wharf. The sheds will be five storeys in height, equipped with plant for handling grain, and will measure 450ft. in length by 110ft. in breadth. They will be constructed of reinforced concrete.

STEADY progress is being made, says the *Iron and Coal Trades Review*, with the Garforth Colliery Company's project on the site at Barnbow. The downcast shaft has been completed, and work since then has disclosed the presence of coal in greater quantities than had been anticipated. The object of the enterprise was to prove the Beeston seam, which has been found, 5ft. thick, while a lower seam gives a further 3ft., so that the company will be able to work 8ft. of first-class house coal. Work will shortly be commenced upon the up-cast shaft.

THE ratepayers of Toronto on January 1st voted for the expenditure of 14,000,000 dollars for the construction of a new waterworks system near the eastern limits of the city, and to duplicate the present intake and filtration plant. The present plant has a capacity of 82,000,000 gallons daily, which, though at present an adequate supply, will not much longer suffice for the needs of a rapidly increasing population. It is also regarded as advisable to have a duplicate system, in view of a possible breakdown in the electrical or steam plants on which the system depends.

AT the end of this month 300 tons of frozen meat from Buenos Aires will be discharged at Barcelona. The importation of Argentine meat is being tried as an experiment at the instigation of the Central Food Superintendent, who is now in Corunna endeavouring to solve the serious problem of scarce and dear meat. One-third of the South American supply imported is for consumption in Madrid, while the 200 tons remaining will be shared between Saragossa and Barcelona. If the experiment succeeds it will be repeated during April. Previous efforts to popularise foreign meat have failed, owing to prejudice and local opposition.

THE Ontario Hydro-Electric Commission is applying to the provincial Government for authority to carry out a project for diverting the waters of the Albany River into Lake Nipigon. After making an exhaustive investigation, the engineers of the Commission report that diversion of the flow of the Albany River from a northward to a southward direction is practicable. It is computed that by such a scheme the flow of water in the Nipigon River would be doubled, which would permit of four power developments where there is now only one at Cameron Falls. It is believed that Virgin Falls, Pine Landing and Camp Alexander could also be utilised for power development, Lake Nipigon serving as a storage basin. The legislature last session made a preliminary appropriation towards the cost of a control dam for Lake Nipigon at Virgin Falls. The total cost of the project is estimated at upwards of 1,000,000 dollars.

THE AUXILIARY ENGINE ROOM OF THE MOTOR LINER AORANGI

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(*For description see page* 111)

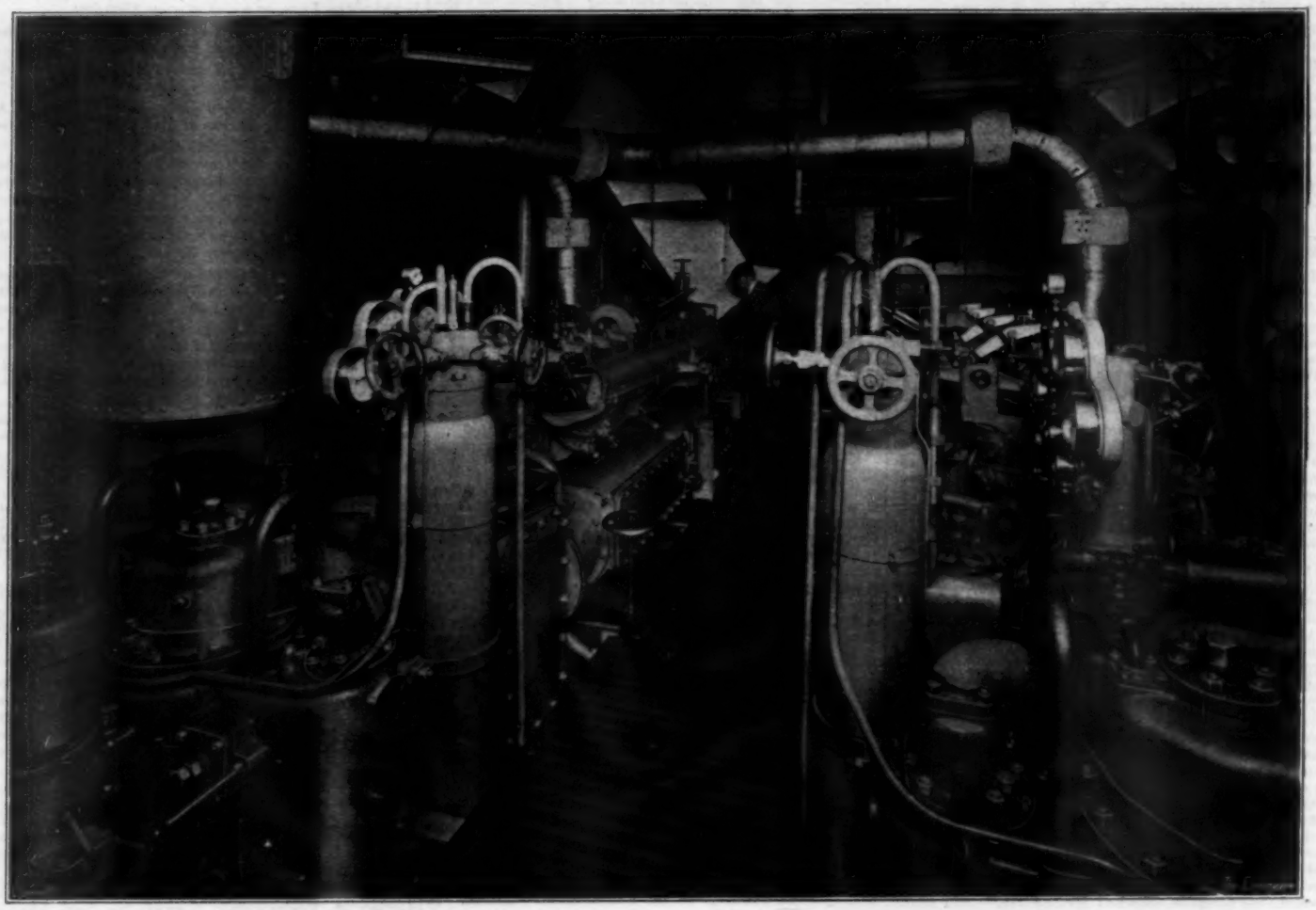

FIG. 25—TOP CONTROL PLATFORM BETWEEN THE TWO PORT GENERATING SETS

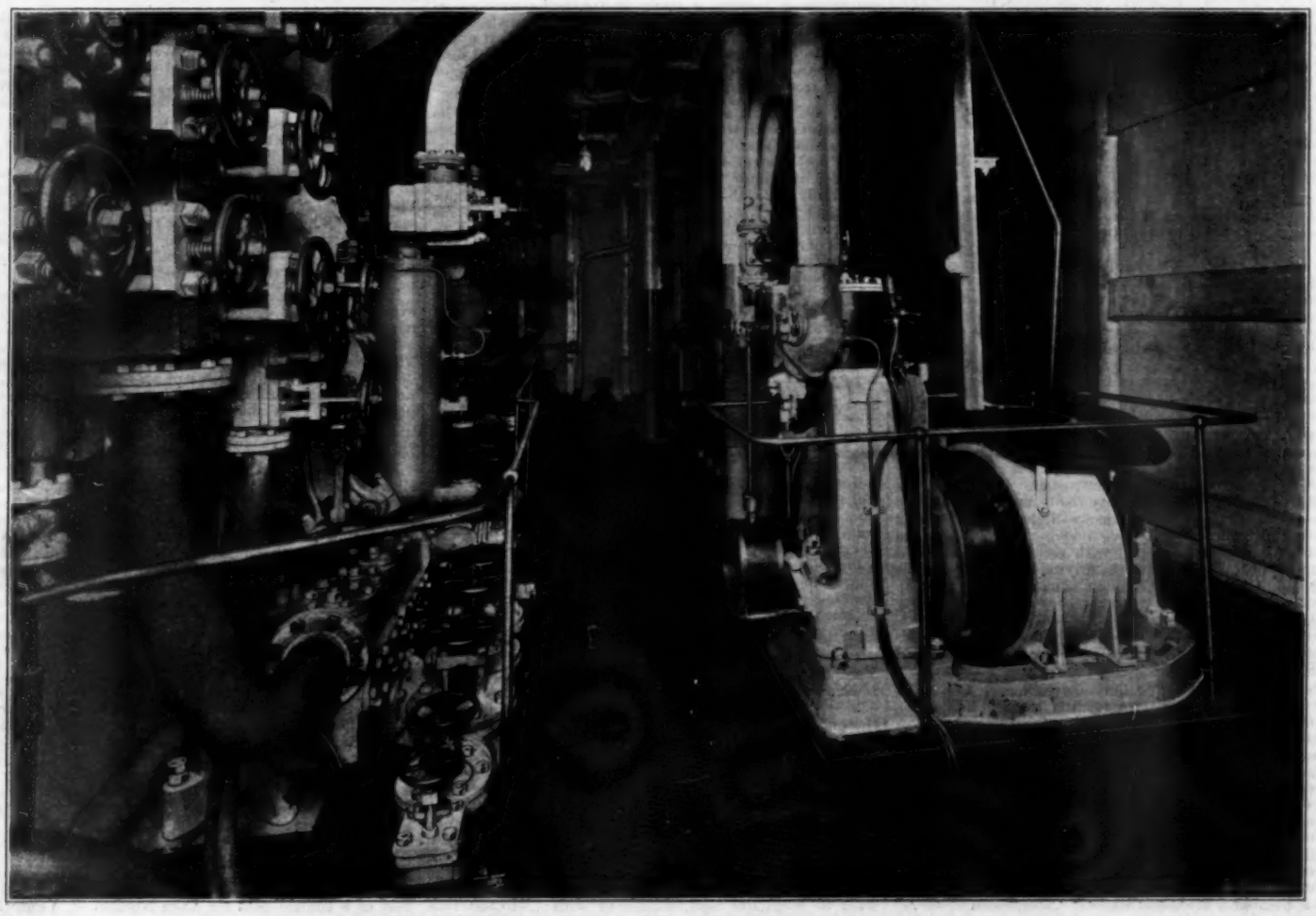

FIG. 26—AFT END SHOWING STEAM-DRIVEN EMERGENCY LIGHTING SET

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Contents.

THE ENGINEER, January 23rd, 1925. PAGE

A SEVEN-DAY JOURNAL .. 93
THE BRITISH STEAM RAILWAY LOCOMOTIVE FROM 1825 TO 1924. No. IV. (Illus.) .. 94
GAS ENGINEERING IN 1924 .. 96
PULVERISED COAL .. 97
THE WATER RESOURCES OF CANADA .. 97
MAIN LINE RAILWAY ELECTRIFICATION. No. IV. (Illus.) .. 98
WATER SUPPLY IN 1924. No. II. .. 100
THE MEASUREMENT OF MECHANICAL VIBRATIONS. (Illus.) .. 102
THE EVOLUTION OF THE STEAMSHIP .. 104
ROADS IN DEVONSHIRE .. 104
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA .. 105
LEADERS—
The Status of Engineers .. 107
High-pressure Cables .. 108
OUR MINERAL STATISTICS .. 108
OBITUARY—W. H. Johns .. 109
WHAT JACKHAMMERS SAVE .. 109
THE MOTOR LINER AORANGI. No. IV. (Illus.) .. 111
NEW WATERWORKS FOR KINGSTON-UPON-HULL .. 113
WELDING PROBLEMS .. 113
SIXTY YEARS AGO .. 114
LETTERS TO THE EDITOR—
Individualism in Locomotive Design .. 114
Waste Heat .. 114
Iron Ore Resources of South Africa .. 114
The Whitworth Scholarships .. 114
THE INSTITUTION OF CIVIL ENGINEERS .. 114
SALARIES OF ENGINEERS .. 114
HIGH-PRESSURE CABLES. (Illus.) .. 115
LLOYD'S REGISTER: ANNUAL SUMMARY .. 116
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 117
Lancashire .. 117
Sheffield .. 118
North of England .. 118
Scotland .. 119
Wales and Adjoining Counties .. 119
CALENDARS, DIARIES, &C. .. 119
LAUNCHES AND TRIAL TRIPS .. 119
CURRENT PRICES FOR METALS AND FUELS .. 120
FRENCH ENGINEERING NOTES .. 121
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 121
FORTHCOMING ENGAGEMENTS .. 122
PERSONAL AND BUSINESS CONTRACTS .. 122

SUPPLEMENT—INDEX TO VOL. CXXXVIII.

The Metallurgist.

With our next issue we shall issue the first of a series of Supplements to THE ENGINEER. *Whilst these Supplements will appear in a different format from that of* THE ENGINEER, *they will not be issued separately, and will only be obtainable by the purchase of the copies containing them. It is proposed to publish one in each calendar month, but on no fixed date.*

Our object in producing these special Supplements is to provide our readers with a record of the most recent Thought and Practice in the realm of ferrous and non-ferrous metallurgy. We believe there is a real need for a publication of the kind in the English language, and we trust "The Metallurgist," the name by which the Supplements will be known, will prove of real value and interest to readers of THE ENGINEER *in all parts of the world.*

THE ENGINEER.

JANUARY 23, 1925.

The Status of Engineers.

IN our last issue we referred very briefly to a report which is of the greatest possible interest to engineers. It was published in Geneva by the International Labour Office and is entitled "Engineers and Chemists: Status and Employment in Industry." It is written in excellent English and the price is 1s. 6d. It was prepared by the Committee on the Intellectual Co-operation of the League of Nations, deals, as the title implies, with what may be described as the human, rather than the technical, side of the engineering profession, and discusses such subjects as the title "engineer," the methods of finding employment for engineers, contracts for employment, insurance, and organisation. The particulars which are given were obtained, not as the results of a questionnaire, the defects of which were appreciated, but in reply to questions addressed to a number of carefully selected individuals in many different countries. It represents, we believe, the first serious attempt to represent the views of all the important nations of the world on the position of the profession and industry to which we belong. In the space at our disposal we can do no more than give a brief review of its contents, but we may advise all engineers who think of their fellows and themselves as something more than machines for invention or production to study it with care.

As already indicated, the first part of the report deals with the title "engineer" and the methods of acquiring it. The difficulties connected with the title are well known, and we need not give space to their consideration, but we are pleased to note that the bulk of opinion is opposed to the proposal, which comes up from time to time, that the title should only be acquirable through certain diplomas and degrees. In this country, as in some others, the term "engineer" is not a title, but simply the name of a profession. We may quote a typical reply from one of the correspondents. "Industry," he says, "stands in need far more of practical and human qualities than of theoretical knowledge. An engineer is always more or less a leader of men; he is rarely an office worker. Human worth of this kind cannot be guaranteed by any certificate, even that of the Ecole Polytechnique. Students fresh from an engineering school must always undergo a period of probation during which their practical capacities can be tested, and energy, promptness and decision are often regarded as more valuable than abstract knowledge." The colleges and universities of many countries grant degrees in engineering, but in nearly all it is recognised that academic work must be supported by practical experience and that not infrequently practical experience may take the place of a college training. Happily, our great institutions maintain a firm attitude on this point and refuse membership to those whose academic studies have not been reinforced by practical training. All of us must agree with the reporters "that in this profession education is merely the best training for practical experience, while practical experience is merely continued education;" indeed, the essence of an engineer's education could not be expressed more accurately and succinctly. We must leave the next section of the report, which deals with the protection of the title, and pass on to the burning question of employment and unemployment. Here we come up against a problem of the very greatest importance. Owing to the attractions presented by technical colleges and by a belief widely held by parents that engineering is such a great industry that there will always be more than enough room in it for all the men that can be turned out, more youths are sent into the profession than it can find occupation for. This view, which we have expressed before now, is supported by the reports from several of the leading nations of the world. Thus we learn that in France there is an excess of engineers of all classes, and the technical schools produce too many engineers, good or bad, for the requirements of French industry. In Germany we find the same thing; an excessive number of students is turned out from the technical colleges. The figures for that country are striking. Students leaving college numbered, in 1919, 12,000, in 1920 nearly 23,000, and in 1921 over 25,500. The increase has continued since, and the excessive number of workers with university education is having an unfavourable effect upon wages and conditions. There is, it appears, no hope of improvement in the near future. In Spain the prospects of unemployment are so serious that some engineers advocate the temporary closing of the technical colleges. In 1922 the Swiss Union of Technicians received 472 applications for employment as against fifteen notifications of vacancies, and possibly as a result of such conditions the number of students in the Swiss technical colleges is decreasing. Such facts as these should be brought to the attention of parents. We would do nothing to dissuade young men who have a distinct bent for engineering from entering the profession; men of that kind are needed. But we would persuade those who have no irresistible call to engineering to ignore the persuasions of our universities and technical colleges and to explore other directions in which they may employ their energies more profitably. There can be no doubt that the low rate of salaries for trained engineers which has exercised so much attention during the past few months is the direct outcome of an excessive supply. As the number of young men who pass through technical colleges becomes greater and greater, the financial value of degrees and diplomas must fall. In the old days the man who could read might escape hanging by pleading benefit of clergy, but when all could read that benefit was rescinded. Nowadays, when all engineers enjoy a college training, the college-trained man cannot escape unemployment by pleading his diploma. He is worth no more than his fellows until he has learnt by experience what no college can teach, or exhibits talents which can be turned to account by financial directors.

It seems to us sometimes, when we study the complaints of engineers, that they leave college with a wrong view of their vocation. The college is all too likely to give them the impression that engineering is a science. So it is within the four walls of the laboratory, but in the factory it is something quite different. There it is a business, with all the humdrum, non-intellectual properties of any other

kind of business. Making machines is exactly on a par with making socks and shirts. It may take longer to learn, it may call for higher qualities of mind, but to the employer who has to make dividends that is all it is. Looked upon in this light, we see that engineers are subject to the law of supply and demand just as any other servant of the money-makers is, and that if too many of them are turned out the value of all those of normal capacity will fall. As in all professions, the super-normal can demand higher pay, but they get it as often as not for the display of business qualities as for the exercise of technical knowledge.

High-pressure Cables.

A PAPER on the Hexaphase system and the compensated three-phase system for 150,000-volt transmission, with records of tests, was read last Friday before the Junior Institution of Engineers by Major A. M. Taylor, of Birmingham. The author has spent a good deal of time and, we should imagine, a fair amount of money on the development of his extra high-tension transmission system, which involves the use of cables with intersheaths. Since he read his paper on the subject before the Institution of Electrical Engineers in 1922—a paper, by the way, which aroused a very lively discussion—certain imperfections in the original scheme have apparently come to light, and new proposals are now put forward. To cable experts the author's original Hexaphase system, which, it should be understood, has not been abandoned, is well known. Briefly, it consists of a system of graded cables with intersheaths, which carry a portion of the working current and special phase connection to transformers, by the use of which the inventor claims important advantages in the use of pressures as high as 100,000 or 150,000 volts. The scheme is based on the well-known theory that if a pressure of, say, 100,000 volts has to be impressed across a slice of insulation, the total thickness of the dielectric necessary to withstand that voltage will be very much less if, for example, the 100,000 volts be divided up into three parts, each of about 33,000 volts, by three strips of insulation, separated by condenser plates, connected to tappings on a transformer, rather than by attempting to put the whole voltage across a solid block of dielectric of increased thickness. There is, however, a division of opinion among cable engineers as to whether the maximum potential gradient is or is not the criterion for the life of a cable. Makers of condenser type terminals are apparently quite convinced that this intersheath principle is advantageous. On the other hand, some cable engineers doubt if the intersheaths are of any real value, or at any rate they maintain that if they are beneficial the improvements do not arise from the re-distribution of the electric stress radially. Mr. Percy Dunsheath has stated, for instance, that if an intersheath cable were left without the ends connected to the transformer tappings, the results would be quite as good as if the ends were connected. This, however, is a matter which has been very widely discussed, and we need not consider it here.

One of the main points which Major Taylor brought to light at last Friday's meeting was that he now realises that the Hexaphase system with its six cables cannot be readily connected to ordinary three-phase transmission lines. It is well known in connection with extra high-tension transmission that one of the matters to be considered is that of carrying the cables through towns and other places where overhead transmission lines are undesirable. Of course, the current can be transformed down at the point of entrance to the section, and transformed up again where the overhead system can once more be used. The disadvantages of this practice are, however, obvious. It is undoubtedly better, if cables can be made to work at high transmission voltages, to avoid double transformation. Major Taylor therefore proposes to employ his high-pressure cables in such cases, but, unfortunately, he has not yet described his proposal in detail; apparently because his latest scheme is not as yet fully protected. The arrangement shown in the first illustration of the paper—published in abstract on another page—would, he says, have been practicable had it not been for the fact that only an inappreciable amount of the power to be transmitted can be passed through the outer intersheaths, and that the capacity currents to be transmitted through the outer intersheaths are so great on a line of any considerable length as to render the system unworkable. He goes on to say, however, that he has made a very great advance by passing the charging kilovolt-ampères for the distant parts of the line through the central core only, and at very high pressure, and by feeding them into the outer intersheaths where required. On the whole, it seems to us that Major Taylor would have been well advised to delay the reading of his paper until he was in a position fully to describe the scheme, although it is interesting to learn that the proposal to utilise the intersheaths for carrying power has apparently been abandoned in this compensated three-phase system, which only calls for three conductors, or six if the line is duplicated. The dielectric losses in extra high-tension cables such as those which Major Taylor describes are not insignificant. For a 40-mile route of 150,000-volt cables they apparently amount to 918 kilowatts, or 1.8 per cent., for a transmitted load of 50,000 kilowatts, and it is easily seen how these losses would mount up on really long-distance transmissions. Although the author is able to show compensating advantages arising from the high pressures at which his cables can be worked, it is pretty evident, we think, that if direct current could be used efficiently the operating conditions would be much better. Moreover, the inductive drop in long-distance overhead transmission lines at full load is generally considerable, unless some form of power-factor corrector is employed to take care of the regulation of the line, and here, again, direct current would show up to advantage. Still, we do not see much prospect of very high-pressure direct-current transmission coming into general use at present. The dielectric losses considered by Major Taylor were based on a 50-cycle supply, and at 25 cycles they would be less. On this account he seemed inclined to argue in favour of a 25-cycle supply, notwithstanding that the particular undertaking with which he is connected has recently installed mercury vapour rectifiers to avoid supplying 25-cycle current to the outlying districts.

It is well that the possibility of constructing cables for a pressure as high as 150,000 volts should be discussed. In the manufacture of cables this country has always held its own. From the time when Dr. Ferranti laid his 10,000-volt cable, which is in use to this day, British engineers have been regarded as the best authorities on high-pressure cable work. Quite apart from the question of whether we shall ever need 100,000 or 150,000-volt cables in this country or not, it behoves our manufacturers to keep an eye on the requirements that may arise abroad. A pressure of 150,000 volts, it is to be remembered, is not regarded as an exceptionally high one in some parts. Unless the practice of running transmission lines down main streets comes into vogue, as apparently it has done in Germany, there should be a very fair demand for extra high-tension cables for use in towns and other populated areas. It must not be supposed, therefore, that Major Taylor's paper deals with a matter that is of little or no interest to British engineers. His views are scarcely likely to be in conformity with those of all the British cable manufacturers, and if he had read his last paper before the Institution of Electrical Engineers, it is not improbable that they would have attacked him just as vigorously as they did in 1922. Still, whatever differences of opinion may exist as to what form 100,000 or 150,000-volt cables should take, the fact remains that there is scope for manufacturers who can produce such cables, and for that reason we are glad to find Major Taylor continuing his propaganda.

Our Mineral Statistics.

IN accordance with our customary procedure we give herewith a review of our mineral output for the year 1923 as recorded in the "Third Annual Report of the Secretary for Mines and the Annual Report of H.M. Chief Inspector of Mines," each of which has a statistical appendix.

The fact that the year 1923 saw two Secretaries of Mines, a condition of affairs repeated last year, does not, of course, affect the statistics of production, nor does it, we imagine, affect any opinions or recommendations expressed in the report, as these will naturally emanate from Sir Thomas H. Mottram, C.B.E., the Chief Inspector. The figures given as our total output of this or that mineral still suffer from the old defect that the output of quarries less than 20ft. deep are not included, as such workings do not come within the purview of the Acts of Parliament with which our inspectorate is concerned. As it happens, the matter is not of much importance, but at the same time it should not be overlooked by students of the statistics of different countries or by those who are searching for information on our economic geology.

On a previous occasion we referred to the figures for limestone production, and a great advance is seen in the present report with regard both to limestone and dolomite, the amount of the output used for such varied purposes as flux, chemical manufacturing, lime burning and building purposes and road-making being given separately. For 1922 the chert and flint output of Wales was given as 1979 tons, described in a footnote as ground flint. For 1923 the output is put at 4288 tons, which, according to a footnote, included 1173 tons of dressed chert valued at £3635, for use chiefly in the china and pottery trades. This is interesting because it shows a revival of the North Wales chert quarrying industry, and it is of further interest as showing the possibility of differentiating between chert and flint, which are by no means of the same market value. The returns of chert and flint for England show 81,737 tons of the average value of 6s. 9d. per ton, no details being given of the tonnage of dressed chert produced in Derbyshire and Yorkshire, and a little more information on the lines of that given concerning the Welsh returns would add to the value of the English figures.

An example of a useful discovery of the destination of a particular mineral is seen in regard to the figures for bog ore, formerly shown in our statistics as coming mainly from Ireland. The English and Welsh output for 1922 was given as 1184 tons, while the figure for 1923 is 17,839 tons. This increased output, however, is apparent rather than real, because it includes iron ore to the tune of 16,859 tons from Wiltshire formerly put in the iron ore figures. Bog ore, which is mainly limonite or hydrated peroxide of iron, finds its main use in gas purification, though all occurrences of brown iron ore, which is mined in five or six districts in England, are not suitable for this application.

There appears to be no new mineral in the returns for 1923 or re-appearance of one formerly mined or quarried; at the same time there is only one absentee from the 1922 list, and that is jet, which indicates that the attempted revival of this old-time Yorkshire industry has not materialised. As in the prior two years, copper ore was not mined at all, though there was the customary, though diminished, output of copper precipitate from old mine workings in Devon and Anglesey. Last year we referred briefly to the projected reopening of gold mining in Wales, not in the familiar district of Dolgelly, but at Punysant in the Cothy Valley, Carmarthenshire. It will be next year, however, before any returns are available, because the London company concerned did not begin operations before the middle of last year.

A feature of the recent post-war reports has been the increased petrological classification of what were formerly described as sandstones, igneous rocks and so on. We now have separate figures for felspar, felsite, felstone, silica, sand silica for refractories, &c. No doubt the wartime researches and the publications by the Geological Survey helped towards this end, a fact which is not without importance, seeing that we now produce, to mention only one item, much of the felspar used in the Potteries instead of importing it from Scandinavia.

Looking at the out-turn statistics generally, it need hardly be stated that coal is far and away our most important mineral, the output being 276,000,560 tons, against 249,606,864 in 1922. Of other minerals, both metallic and non-metallic, it is satisfactory to note that production was in most cases above that of 1922, though as regards metallic ores we are still a long way behind pre-war figures.

A feature of the report compared with those of earlier date is the detailed reference to what may be termed ameliorative research. Various committees are at work on such matters as the Miners' Welfare Fund, mining subsidence, &c., and the subjects of mining research and health and safety in the mining and quarrying industries are treated under various headings. Incidentally we may mention that baths at metalliferous mines now find their first mention, though the development so far has not been rapid. Where adequate washing accommodation is provided the returns show that in many cases patronage is very indifferent, a Dorset mine with two men showing a daily average of two baths, easily holding the record for cleanliness! In Appendix C is given the membership of the Advisory Committees appointed under Section 4 of the Mining Industry Act, as well as of various other Committees considering matters connected with the mining and quarrying industries.

COAL.

The average commercial pithead price of all coal was 19s. 9½d. per ton, about 1s. per ton more than in the preceding year, while the value of exported coal was 25s. 2d. per ton f.o.b., or 2s. 7d. more. Working costs still hamper old largely worked out mines with narrow and tortuous roadways, compared with the conditions under which the owners of the new pits working the Barnsley bed to the east carry on business. Yet some concerns paying comfortable dividends have been examining abandoned mines in old centres with a view to reopening, and some small properties which mainly required adequate capital have been re-started. About 17¼ million tons of coal were used in the manufacture of gas, against 16¼ million in 1922,

but regarding to the carbonisation in coke ovens, both of the beehive and recovery types, a much greater rise is recorded, *i.e.*, nearly 20 million tons, against 13¼ in 1922. These figures are reflected in Table 29, Appendix A, where the export of oven coke to Germany is shown at 1,142,323 tons, against 235,408 tons in 1922. Shipments to other countries show no great variation. The Scandinavian countries remain the principal market, and it is noticeable that the pre-war preference for gas coke is by no means so pronounced as it was, oven coke being now taken in increasing quantities for central heating, according to specification. Of the various types of recovery oven in use the Otto-Hilgenstock heads the list with 2109, followed by the Koppers with 1907, Simon-Carves 1905, and Semet-Solvay 1347, other types being in considerably smaller numbers. The quantity of coal used for briquette making was 1,049,360 tons, against 1,211,148 tons in 1922, the industry being under a cloud owing to the high price of pitch.

IRON.

The output of iron ore from all districts was 10,875,211 tons, against 6,836,507 tons in 1922, thus testifying to the improvement in the smelting industry, the low-grade ore districts of the lias and oolite of Lincolnshire and the Midlands accounting for the great bulk of the increase, though both the Cleveland lias ore and the North Staffordshire blackband ore were mined in largely increased quantities, as also was West Coast hematite. The position of the Cleveland industry has been much affected, it is pointed out in the Secretary for Mines' Report, by recent developments in the lias ore mining in Northamptonshire and other Midland districts. Here the ore is near the surface and can be quarried and dredged for 3s. 2d. per ton into wagons. Cleveland ore, on the other hand, being got from depth, costs 7s. 7d. at the surface, and after allowing for railway freight the Midland ore can compete successfully at Middlesbrough. With regard to our home supplies of rich ore there is no doubt that the mining industry of Cumberland and Furness is largely affected by our large imports of hematites and magnetites of over 50 per cent. iron. Imported ore, which amounted to 3,472,575 tons in 1922, rose in 1923 to 5,870,996 tons. The returns of the Board of Customs and Excise showing the countries of origin are not now given in these statistics, but it may be said that Spanish hematite heads the list, followed by the magnetic ore of Swedish Lapland.

MANGANESE AND OTHER ORES.

The home production of manganese ore is but a fraction of our requirements. We note that the Merionethshire output rose from 250 tons in 1922 to 1663 tons, while the Carnarvon mine was reopened with a yield of 358 tons. The imported manganese ore amounted to 517,782 tons, against 329,396 tons in 1922, a considerable bulk of which came from the new Mount Sinai mine. A fall in the output of uranium ore in Cornwall from 393 tons in 1922 to 4 tons in 1923 indicates that the mining of pitchblende was not active, whatever may have been done at the new plant at the South Terras mine for the preparation of radium salts and uranium oxide. The output of dressed lead ore was 12,499 tons, against 11,079 tons in the preceding year. The most important mines as regards tonnage of concentrates are Boltsburn (Durham), Queensbury (Dumfriesshire), Mill Close (Derbyshire), Lead Hills (Lanark), Nentsbury (Cumberland), and Greenside (Westmoreland). There is only one novelty in this list, and that is the great advance made by the Nentsbury mine in the old mining district of Alston Moor, which is being worked again now in one or two places that are not too inaccessible. The position in Flintshire has not altered for the better, and lead mining in the important Halkyn Mountain district is at a complete standstill. The remarks in the Secretary for Mines Report are much the same as in the two preceding reports as regards the deep level drainage tunnel. We are again told that negotiations for the amalgamation of the mining and drainage interests are still in progress. It is now more than ten years since the Milwr tunnel was started with insufficient capital, and about a mile still remains to be driven. It is a great pity that terms cannot be come to for the completion of the work if only for the relief of unemployment. We are not desirous of being accused of socialistic leanings, but it may be mentioned that the big drainage adits driven years ago in Germany, Czecho-Slovakia and other European States were all carried out by the sole owner of mineral rights in the respective districts, *i.e.*, the Government, and so there were no conflicting interests to be harmonised and, moreover, the necessary capital was available. In Derbyshire, although there has been considerable capital expenditure in the old Wirksworth district, where it is hoped to find good lead under the Yoredale shales to the east, there has not yet been any material augmentation of output, certainly not to the extent one might imagine from various Press reports. In Table 8, Appendix A, where the output of ore from the various mining fields is given, the average values for the concentrates of the different districts seem to require something in the way of explanatory footnotes. Thus the North of England ore assaying 80 per cent. metal has the stated value of £17 0s. 2d. per ton; the Derbyshire ore, also 80 per cent. metal, is put at £14 11s. 5d., while the Welsh and Isle of Man, assaying 78 per cent. metal, is £21 3s. 2d. Presumably the difference is due to the silver contents of the ore, the Carnarvonshire and Isle of Man ore being highly argentiferous. Another point: as the average assay from all the important districts is given as 80 to 81 per cent., there must be some good dressing done with the production of 82 per cent. ore if the totals include the lower assay slime ore. Turning now to tin, the total yield of dressed ore or "black tin" in Cornwall was 1760 tons, showing a great increase over 1922, when the output fell to 650 tons. Various factors have helped in the revival, the most important being the upward move in prices. During the year Geevor, Kingsdown, South Crofty, Tincroft and Tresavean resumed crushing, and as some of them began late in the year we may expect a further increase to be recorded in the 1924 totals. That faith in the future of this old mining industry is still strong is evidenced by the development work in active progress in many of the districts, especially where the important by-product of arsenical pyrites is obtainable.

Passing on to zinc, it may be mentioned that it is nowhere worked alone at the present time, the total output of 2124 tons coming from the lead mines. Though the figure is in advance of the 1620 tons of 1922, it is a long way behind that of a decade ago, when the Vieille Montagne Company was working the Nenthead and Carshield mines in the North. The only feature in the returns worth notice is the yield of 884 tons of dressed ore by the reopened Great Laxey mine in the Isle of Man, and it is clear that, despite the impoverishment proved at depth by the old company, there still remains a good deal of accessible ore. Imported sulphide concentrates amounted to 53,746 tons, and other ores, mostly calamine, to 6869 tons, so the South Wales smelters were not idle. Crude metal or spelter was imported to the value of £4,717,498.

FLUORSPAR.

The total output of fluorspar was 49,031 tons, the three counties of Derbyshire, Durham and York being the producers in order of merit. This is now the third year that Yorkshire has contributed to the output, the supply, except for trifling amounts from Cornwall, having always come from Derbyshire and Durham. Yorkshire, with an output of 5263 tons, is clearly a competitor with which the old producing areas have to reckon, and the matter is of particular interest because in the Special Report on Fluorspar, issued during the war by the Geological Survey, Yorkshire as a potential producer is dismissed in a few lines, though the statement that the spar occurs nowhere in workable quantity applied only to the old mining regions of the higher parts of Swaledale and Wensleydale. In Derbyshire, where the output has increased, there have been several changes in the sources of production. One of the most important mines suddenly gave out and the owners were hard put to it to fulfil contracts. This led to a new venture in another district, and the success attained soon led to old lead veins in various districts being taken over by other capitalists. A good deal of the Derbyshire output is low-grade material, *i.e.*, the gravel, which is exported in considerable quantity to the United States, where it is in demand in the steel and chemical industries. The best lump mineral goes to home steel works, where its use has much increased of late years. Our exports of fluorspar are given as 31,367 tons, a large proportion of our output.

ARSENIC, &c.

The production of arsenious acid and arsenic soot in Cornwall was 991 tons, against 661 tons in 1922. In Devon the figures were 614 tons, against 317, so that considerable progress has to be recorded. The increased use of arsenical insecticides in the American cotton plantations is the cause of the rise in price, and the increased outputs in the arsenic mining centres of the world. In addition to the above, arsenical pyrites was also mined to a considerable amount in both Cornwall and Devon. It is noteworthy that white arsenic or arsenious acid was imported to the amount of 2767 tons, a figure much larger than in 1922, so it seems that we are a long way off supplying our own needs unless this imported arsenic is re-exported in the form of chemical preparations—a matter on which we have no special knowledge. The output of barytes, sulphate and carbonate was 43,497 tons, against 40,949 tons in 1922. This comprised both lump and ground qualities. The imports of ground barytes amounted to 35,566 tons. If we include Bute with its modest output of 26 tons, the number of producing counties was eleven, the same as in 1922, the order of merit as regards output, but not necessarily with respect to quality, being Salop, Durham, Ayr and Derby, to mention the leading four. Actually in point of output Northumberland comes second, but as this is all witherite or the carbonate from the Settlingstones mine, we do not include it in the list of sulphate producers. The most noteworthy feature of the statistics is the re-entry of Ayr into the list of producers, with 3967 tons. The mine was first developed during the war, but ceased production in 1922 for reasons which were obviously unconnected with any failure of mineral.

The china clay industry of Cornwall and Devon was well maintained, the total output amounting to 720,533 tons, being 86 per cent. of the 1913 total. America has always been a large importer and now further demand has arisen for the coating of newsprint. Cornwall also produced 51,343 tons of china stone, a good deal of which finds its way to the Staffordshire Potteries. Our exports of china clay and stone were 522,758 tons, our other clays being exported in very much smaller amount.

The output of iron pyrites was 6908 tons, against 5669 tons in the preceding year. We believe that the whole of this was coal brasses from coal mines, as the Government pyrites mine started in North Wales during the war has been abandoned. Owing to its freedom from arsenic coal brasses find a special application in the vitriol manufacture, though, of course, the bulk of our vitriol is made from imported pyrites and also of recent years to a considerable extent from brimstone, since the price has been favourable. The exact imports of pyrites mainly from Spain and Portugal are not given, but in the comments on iron ores we read that 253,161 tons of purple ore—that is, pyrites cinders—were available for our iron industry, this figure being 75 per cent. of the raw pyrites imported, so that we must have imported over 300,000 tons. We do not quite agree with the designation of this pyrites as cupreous, because, since in recent years the wet copper extraction plants have largely been inactive, the tendency has been to import non-cupreous pyrites, or, at any rate, pyrites so low in copper content that it does not enter into consideration in the selling price.

The output of salt as brine in Great Britain and the Isle of Man was well maintained, the figure being 1,938,910 tons, against 1,844,825 tons in 1922, the rock salt increasing from 26,572 tons to 37,886 tons. We believe that a year or two ago under special circumstances some coal was sent to Newcastle, and it is a fact that since the war salt has been coming, though not in large quantities, to the headquarters of the Cheshire industry from Germany, a matter with which the exchanges have doubtless had something to do. With regard to another product of the Triassic formation, gypsum, to wit, the output was 317,676 tons, against 257,460 tons in 1922, activity in the building trades, the increased use in cement, and one or two other factors contributing to the larger demand. Another Triassic product, the rarer celestine or sulphate of strontium, worked in Gloucestershire, amounted to 6346 tons, against 4711 tons, this being one of the few minerals in which we do not have to meet any real competition from other countries of the world. Our space is now exhausted, and we shall conclude with the notice that the output of oil shale in Scotland was 2,860,633 tons, against 2,603,996 tons in 1922, showing that the industry is well maintained under its new control.

Obituary.

W. H. JOHNS.

WE regret to have to report the death of Mr. W. H. Johns, of "Clears," Reigate, which took place rather suddenly on the 9th inst., following an operation. Mr. Johns, who was fifty-four years of age, had for many years past filled the position of manager of the instrument department of Johnson and Phillips, Limited, Charlton, with which firm he had been associated practically all his working life, having joined it in 1890 after an apprenticeship served with J. Stone and Co., Limited, of Deptford.

WHAT JACKHAMMERS SAVE.

ACCORDING to Mr. Hulton, Government Inspector of Mines, of Germiston, it has been proved that the new jackhammers of the heavy type, which are being used in a number of mines on the Witwatersrand, will drill as much as 130ft. in a sh ft of eleven hours, thus making one machine drill equivalent to a large gang of hammer boys. It has also, he states, been proved that stoping by jackhammers is considerably cheaper than hand hammer stoping. The manager of the Witwatersrand Gold Mining Company has in this connection made a series of careful comparative tests of the efficiency and cost of breaking ground in several stopes. The results were as follows:—

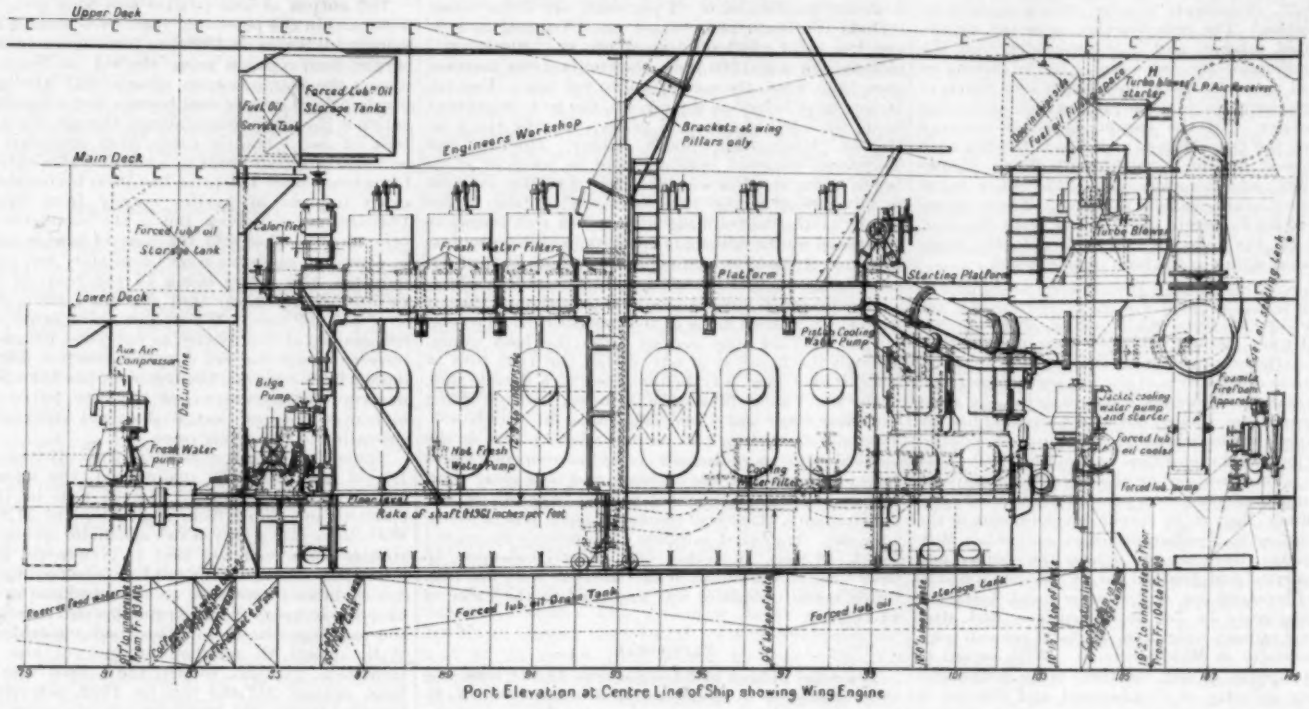
	Cost prior to installation of new type of jackhammer. S. per fathom.	Cost after installation. S. per fathom.
White wages	10.64	10.36
Native wages	27.79	5.11
Explosives	11.52	9.57
Other stores	4.25	3.33
Machine costs	14.38	15.40
Total	68.58	43.77

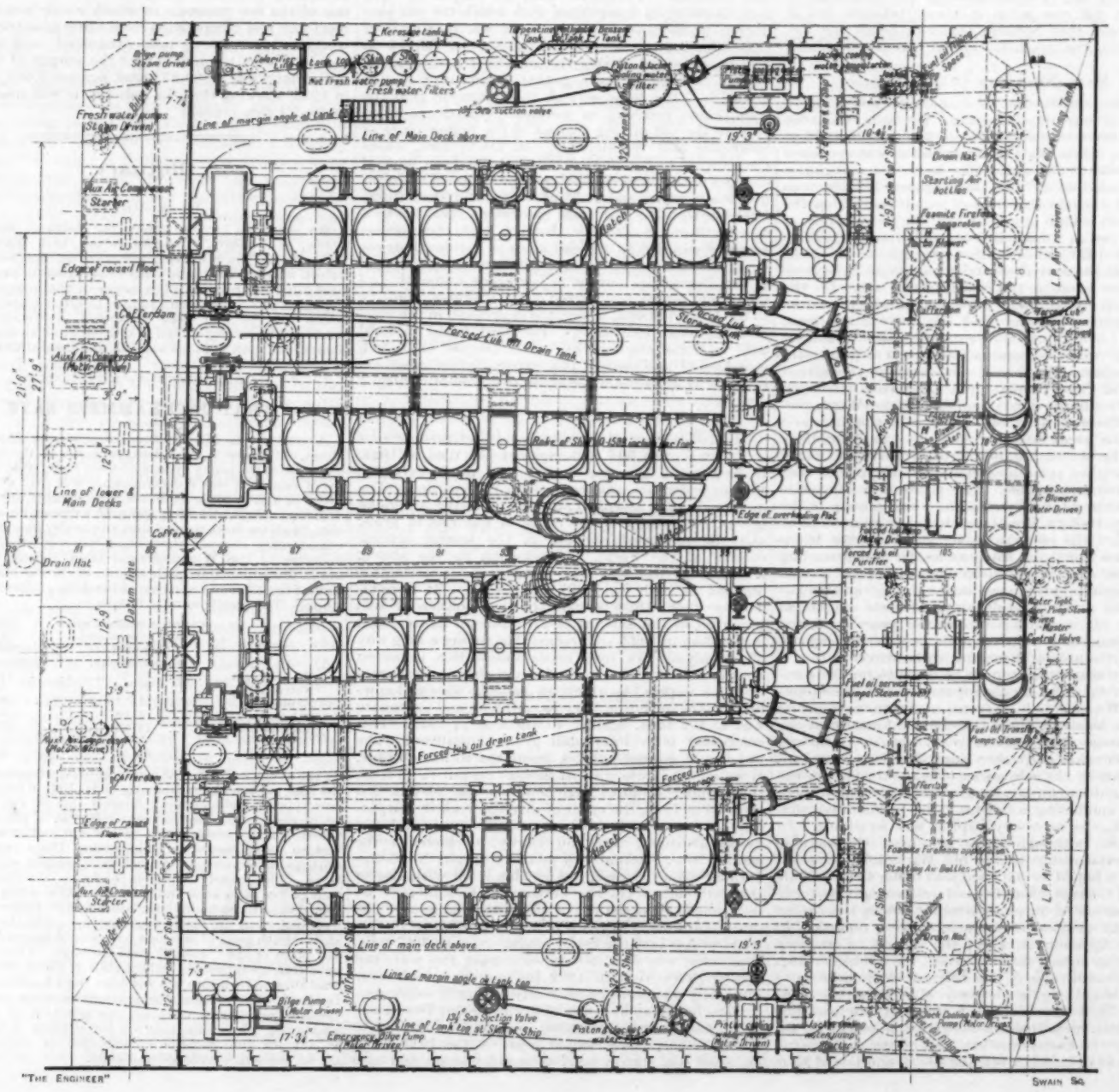
As the average width of the ground being stoped was 54in., the cost per ton shows a saving of 1s. 10d. in favour of the new type of jackhammer. Against this saving, however, an increase of 9d. per ton was incurred in shovelling, as the stopes in question were of low dip and extra natives had to be employed on this work. These results were obtained by employing two relays of gangers and machine boys. The "early" miners examine and dress down four to five faces each and start the machine boys on drilling. Some three hours later other miners follow and take over one, or at the most two, machines each. Later in the shift a fresh gang of machine boys would descend and take the place of the "early" machine boys. Thus it will be seen that a continuous drilling shift of about eleven hours was obtained without the machine boys becoming greatly fatigued. The proof of the capabilities of the new type of jackhammer would open up the question of profitably employing white men only on the drilling of holes were it not for the phthisis contribution of approximately 5s. 6d. per white underground shift.

THE MAIN ENGINE ROOM OF THE MOTOR LINER AORANGI

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, GOVAN, GLASGOW, ENGINEERS

(*For description see opposite page*)





"THE ENGINEER" SWAIN SC.

The Motor Liner Aorangi.

No. IV *

MAIN ENGINE AUXILIARY SERVICES.

THE drawings which we reproduce on page 110 show the general arrangement of the engine-room auxiliary machinery in relation to the main propelling engines.

Scavenging Air Supply.—The three electrically driven turbo-blowers which supply the scavenging air, and to which as yet only passing reference has been made, are housed at the forward end of the main engine-room, the blowers and motors being placed slightly higher than the starting platform level. These machines were built by Brown, Boveri et Cie., of Baden, Switzerland, and are, we are informed, among the largest of their type yet constructed. The electric motors which drive the blowers are designed for an output of 430 brake horse-power at a speed of 3150 r.p.m., and the silent running of the blower sets at that speed may be remarked upon. Each blower is designed to deliver 560 cubic feet of air per second, against a pressure of from 1.75 lb. to 2.1 lb. per square inch, but the rotors are provided with adjustable diffuser blades which were set at the most efficient angle after the shop trials. When the four main engines are developing full power, two blowers serve to supply all the scavenge air required, and the third stands by.

It will also be seen from the drawing reproduced on page 110 that all three blowers discharge into a common main, running athwart-ships, each end of which is furnished with a breeches piece, which supplies air to two main engines from. On each of the scavenging air trunks throttle valves are fitted. They may be used to regulate the supply of air to cut it off from any particular engine, as may be desired. The starting controllers of the motors are placed in a convenient position on the main starting platforms. With a view to eliminating that slight ringing noise which is always associated with high-speed machinery, the inlet trunks and suction casings of the blowers have been specially designed, and are well insulated from adjoining structures by a layer of Mascolite, a compound which is largely composed of cork and hard felt. The air intakes are on the boat-deck, and we were impressed by the absence of noise, both on that deck and in the passenger spaces and public rooms adjacent to the air inlet casing and trunks.

Starting Air Supply.—The main supply of starting air is stored in two groups of five starting air bottles, placed vertically near the corners of the forward engine-room bulkhead at bottom platform level. The receivers are designed for a working pressure of 1000 lb. per square inch, and are fitted with water and oil drains. Immediately above each group of high-pressure receivers there is placed a built-up steel receiver for low-pressure air—350 lb.—which is supplied through a reducing valve on the high-pressure system. Two of the high-pressure bottles are so arranged that they can be isolated from the reducing valve, and kept at full pressure, so as to provide an emergency supply of injection air. When the engines are in operation surplus compressed air is by-passed from the main and auxiliary engine compressors, and the supply so obtained is amply sufficient to make up the quantity of starting air which is normally required. The auxiliary and emergency air compressors which are used for manœuvring and starting purposes were supplied by Reavell and Co., Limited, of Ipswich. They include two motor-driven compressors, each designed to deliver 150 cubic feet of air per minute at a final pressure of 1000 lb. per square inch, and a small steam-driven emergency compressor of 25 cubic feet per minute capacity, which may be used in the remote case that all the air vessels in the ship are depleted. Under such conditions this little compressor could charge the air receivers of one of the auxiliary generating sets in a short time, when, as soon as the engine had been started, the motor-driven compressors would again be used. The two motor-driven compressors referred to are placed near the after bulkhead of the main engine-room—as shown in the drawing reproduced on page 110. Under actual working conditions there is always a considerable surplus of air from the compressors on the main and auxiliary engine that it is probable the auxiliary and emergency sets will seldom be needed.

The sea trials of the Aorangi included a series of elaborate manœuvring tests, which would have proved severe to a steam-operated ship. The programme was, however, carried through without a hitch, and the machinery during these trials exhibited, we learn, a high degree of flexibility. The large astern power—which is equal to that ahead—and the extra turning moment of the two outer propellers, both contributed to the good results obtained.

Cooling Water Arrangements.—Sea water is utilised for cooling the piston heads, cylinder jackets, covers, air compressors and for other services. The main jacket supply pumps, which are placed in the wing spaces of the main engine-room, are of the Drysdale vertical motor-driven type, and are two in number, each designed for an output of 600 tons of water per hour against a head of 60ft. This quantity of water is amply sufficient, we learn, for cooling the engines when they are working under tropical conditions. The centrifugal pumps referred to are compact in design, and were noticeably quiet in their running.

Before it enters the pump the water is screened and filtered by means of perforated plates and woven fibre, so that all solid matter is removed from it. The filters both for the main and auxiliary engines, as well as the boiler feed filters, were supplied by J. H. Carruthers and Co., Limited, and are arranged with suction branches and control valves at the middle of the two wing spaces. The water on leaving the pumps enters the air compressor and intercooler system, shut-off cocks being fitted so that in the event of an intercooler tube bursting the water supply system for that compressor can be cut-off. From each high-pressure compressor cylinder cover a discharge pipe is taken direct overboard, and by temperature observations the rate of supply can be regulated. After passing through the compressors, the same cooling water is used in the main cylinder jackets and covers, a by-pass connection being taken to the fuel valve casings. From the cylinder covers the cooling water passes through the water-cooled exhaust pipes to an overboard discharge main.

The piston cooling water is supplied from a separate circuit which is connected with two geared motor-driven duplex bucket pumps of the Weir type. Each of these pumps is designed for an output of 130 tons of water per hour, against a head of 130ft., one pump being used as a standby unit. The water is filtered before entering the pistons, which it reaches through the system of telescopic pipes, described and illustrated in our last article. The system is so designed that the heads of the pistons are always drowned with cooling water. For pumping the heated water which is discharged from the pistons overboard two bilge pumps, one electrically operated and built by G. and J. Weir, Limited, and a steam pump by Thom Lamont and Co., Limited, are fitted. Other water pumping machinery arranged in the main engine-room space includes cold and hot fresh water pumps with a calorifier and fresh water filters.

Lubricating Oil System.—In our last article we described the mechanically operated pressure lubricators, which supply oil for lubricating the main cylinders and air compressors. The main bearings of the engine are lubricated from a separate gravity system supplied from large storage tanks fixed in the engine-room hatch at main deck level. A motor-driven geared pump of the twin-bucket Weir type lifts the oil from the drain tanks in the double bottom to the elevated storage tanks, while two steam-driven simplex pumps, also built by G. and J. Weir, Limited, are used as standby plant. Should a higher lubricating pressure than that given by the gravity system be required, oil may be delivered to the bearings at the full delivery pressure of the pump through connections provided for that purpose. Separate connections are taken to each of the main engine crankshaft bearings, and the cranks are drilled internally so that lubricating oil finds its way to the crank pins. A tapping is taken from the system for the purpose of cooling and lubricating the cross-head guide faces. Reference has already been made to the special crosshead lubricating pumps, which are driven direct from the engine crank shaft and which supply the crossheads with oil at a pressure of about 250 lb. per square inch. In an emergency the engine can be run at reduced power without using these pumps, the crossheads being lubricated either from the gravity system or from the main lubricating pump delivery main as just noted.

Between the engines, as shown in the drawings reproduced on page 110, there are large lubricating oil drain tanks arranged in the double bottom spaces. On each suction pipe to the pump there is a magnetic separator and on the delivery side of the pump duplicate filters formed of fine-meshed metal gauze are provided. A Serck oil cooler, which is connected on the cooling water side to the main jacket cooling system, is also fitted. Three electrically driven centrifugal oil purifiers of the De Laval and Sharples types, supplied by Chadburn's (Ship) Telegraph Company, Limited, Liverpool, and Super-Centrifugal Engineers, Limited, London, respectively, are fitted for treating the main bearing oil, one purifier being installed in the auxiliary and two in the main engine-room. In the main engine-room there is a large oil settling tank fitted with steam heating coils. It is placed alongside the gravity supply tanks at main deck level. A motor-driven portable pumping set of neat design is stowed in one of the filling spaces, and may be used either on the ship or on the quay when filling operations have to be carried out.

Oil Fuel System.—As already shown in the drawings given, the main oil fuel tanks are placed between the main and auxiliary engine-rooms, and in the double bottom of the ship below the machinery spaces. All tanks are used for Diesel oil, with the exception of one, which is reserved for boiler oil.

Particular arrangements have been made to facilitate the rapid fuelling of the ship by providing filling spaces at either side of the forward end of the main engine-room, just above control platform level. These filling spaces have pipe connections to the various oil bunkers and flexible fuel hoses. The oil transfer pumps are of the familiar Weir type, and, in addition to the usual transfer duties, they are designed to fill the daily ready-use tanks for the auxiliary engines and also to pump oil to the settling tanks for the boilers in the forward engine-room, a special pipe line for this purpose being fitted. The main engine service tanks are fitted at the after end of the engine-room and are furnished with a float control connected with two Weir type service pumps, one of which serves as a standby unit. The purpose of the float is to regulate the amount of steam supplied to the pumps and thus maintain in the tanks a constant head which must not lift the suction valves of the fuel pumps. The ready-use tanks of the main engines are all designed for a run of twelve hours. It may be noted that the service oil tanks are fitted with Pneumacator mercury gauges supplied by Kelvin, Bottomley and Baird, Limited, of Glasgow, while the bunker tanks are fitted with instruments supplied by the Fox Instrument Company. The equipment is such that an accurate record of the fuel consumed during each day's run can easily be kept. For the purpose of dealing with oily bilge water an oil and water separator of the Knight and Dunford Smith conduit type, which was described in THE ENGINEER of June 29th, 1923, has been fitted in the ship. Foamite-Firefoam fire-extinguishing apparatus is fitted in both engine-rooms.

Engine-room Workshops and Stores.—At the port side of the main engine-room is a large and well-equipped engineers' workshop. Among the machines in it we noted a 7½in. lathe and a drilling machine by Loudon Brothers, Limited; a 3½in. lathe and milling machine by Drummond Brothers, Limited; and a Luke and Spencer grinder. Ample bench accommodation is provided with a good assortment of engineers' tools, and the equipment should go far in carrying out any necessary repairs either to the engines or the auxiliary machinery. At the starboard side of the engine-room there is an engineers' store, which contains a large number of spare parts, the more bulky being neatly cleated to the bulkheads.

THE FORWARD AUXILIARY ENGINE-ROOM.

In Fig. 29 we give drawings showing the general arrangement of the four Diesel-electric generating sets and the two heating boilers, which, together with the auxiliary pumps, are placed in the forward engine-room. On page 106 we reproduce two photographs, Fig. 25, showing the top platform between two of the auxiliary engines, and Fig. 26, illustrating a bottom platform view at the aft end of the engine-room looking to port. The latter illustration also shows the small steam-driven emergency lighting set. The main particulars of the four four-cylinder Sulzer-Allen generating sets are as follows:—

Diameter of cylinders	13¾in.
Stroke	21¼in.
Running speed	200 revs. per min.
Generator output	300 kilowatts
Circuit voltage	220 volts

The four engines were built by Sulzer Brothers, of Winterthur, and are of the firm's well-known two-cycle type. They are coupled direct to generators, built by W. H. Allen, Sons and Co., Limited, of Bedford. A view of one of the complete units looking at the compressor end is given in Fig. 27. It may be remarked that each engine is complete with its own compressor and scavenge pump, while other pumps, driven from the crank shaft, include salt water piston and jacket-cooling pumps, and a main crosshead lubricating pump. This pump equipment renders the engine completely self contained. Two standby lubricating pumps of the horizontal type, worked by compressed air, are fitted, and for operation under tropical conditions oil cooler for each engine.

An interesting feature of the auxiliary engines is the arrangment which is made for the automatic control of the fuel pump and air injection pressure, and the fuel-valve lift by means of a special governor arrangement. This automatic control insures that the engines run at constant speed, and under the most economical conditions, no matter what change in load takes place.

Main Switchboard.—In Fig. 28 we give an engraving showing the main switchboard, which is erected on a raised gallery at the after end of the engine-room. It has fifteen panels, and was supplied complete with instruments by the General Electric Company, Limited, of London. It is designed for 220-volt supply and distribution. Four panels are set apart for the 300-kilowatt main generators, three for the 450 brake horse-power motors, which drive the turbo-blowers, while a further panel is used to interconnect the emergency switchboard on the boat deck with the main bus-bars. The remaining panels are arranged to control the various feeder circuits for the electrically-operated auxiliaries, and they include four 300 ampère circuits, the same number of 200 ampère circuits, ten 150 ampère circuits, and five 100 ampère circuits. As will be seen from the illustration, the board is provided with an insulated handra l running along its entire length, and it is well served from the raised gallery also shown. We have already referred to the 36-kilowatt Weir-Sulzer airless injection emergency lighting set installed at boat deck level. Another emergency set is the 10-kilowatt Allen steam-driven dynamo, shown in Fig. 26, page 106. It is intended for use in port when the auxiliary engines are not required, or for lighting the machinery spaces in the case of emergency.

Heating Boilers and Auxiliaries.—At the forward end of the auxiliary engine-room, and screened off in a separate compartment, are the two boilers shown in

* No. III. appeared January 16th.

Fig. 29. Each is of the single-ended multitubular type, and is 13ft. in diameter and 10ft. 6in. long. There are three furnaces to each boiler which are oil fired on the Wallsend-Howden system, duplicate installations, each capable of dealing with 1350 lb. of oil per hour, being fitted. As the drawing shows, the boiler uptakes are run into one funnel, and are carried to the top of the forward funnel of the ship. Alongside them will be seen the four exhaust pipes from the auxiliary engines, complete with their silencers, and the waste steam pipe and the atmospheric exhaust connection. The auxiliary machinery includes two Drysdale motor-driven 5in. sanitary pumps, a general service pump, which is steam driven, by Thom Lamont and Co., Limited, a ballast pump by J. H. Carruthers and Co., Limited, a Weir evaporator, and a distiller by Caird and Rayner. The auxiliary condenser is shown in Fig. 29. The circulating pump, was supplied by Workman, Clark and Co., Limited, and the feed pumps and evaporators by G. and J. Weir, Limited. In the various drawings given in connection with these articles, the elaborate arrangement of the air-ventilating trunks in the machinery spaces will have been noted. It is most desirable to maintain a fresh supply of air throughout the machinery spaces, and although provision has been made for an ample supply of natural ventilation, many pressure fans and exhausters are to be found in the vessel. In the main engine-room these fans supply air to both the top and bottom platforms, while air is exhausted from below the control platform and discharged into the suction casing of the turbo-blowers. The ventilating arrangements have received very careful attention, with a view to dispelling completely any oil mist or vapour which might tend to collect in the engine-rooms, especially under tropical conditions. In the auxiliary engine-room alone over 50 square feet of trunking, giving natural air supply to the engine and boiler-rooms, is fitted, besides auxiliary ventilating fans. Another means of changing the air in this room is provided by the air intakes on the scavenging pumps of the auxiliary engines, one of which is shown to the right of Fig. 25 on page 106. These intakes also act as silencers, and the general running of the auxiliary engines was remarkably quiet.

From the description which has been given it will be understood that most of the auxiliary machinery is electrically driven. At sea only one boiler is required for heating, domestic and pumping services, but both boilers are used in port when the steam winches are in operation. The amount of fuel used by the auxiliary engines is remarkably small, and we may recall the excellent consumption obtained on the trial runs, when the oil used by the auxiliaries was only 0.036 lb. per brake horse-power of the main engines.

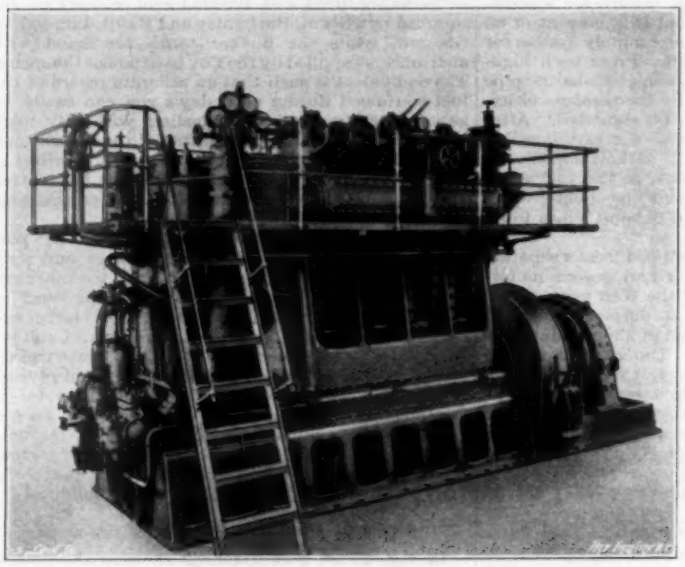


FIG. 27—SULZER ALLEN GENERATING SET

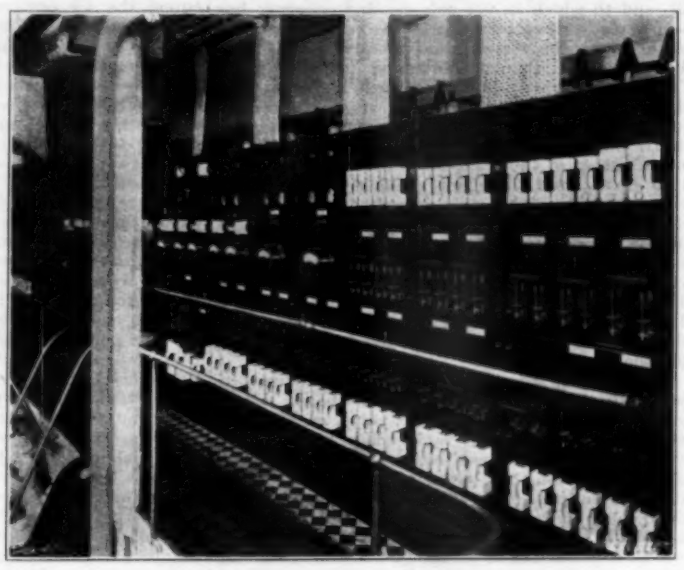


FIG. 28—MAIN SWITCHBOARD

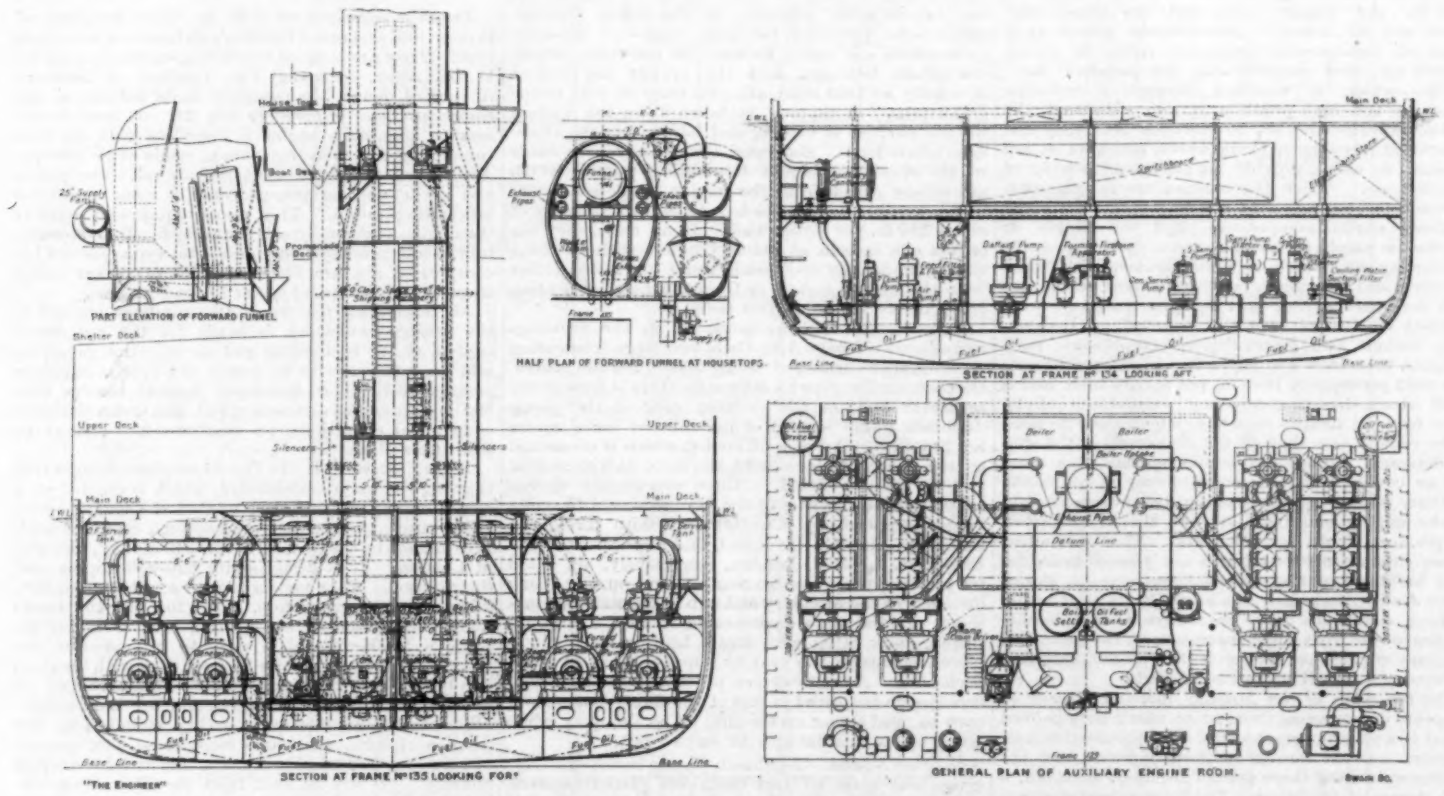

PART ELEVATION OF FORWARD FUNNEL
HALF PLAN OF FORWARD FUNNEL AT HOUSETOPS
SECTION AT FRAME No 134 LOOKING AFT
SECTION AT FRAME No 135 LOOKING FOR'
GENERAL PLAN OF AUXILIARY ENGINE ROOM
"THE ENGINEER"

FIG. 29—GENERAL ARRANGEMENT OF MACHINERY IN THE FORWARD AUXILIARY ENGINE ROOM

CONCLUSION.

From the description of the Aorangi which we have given, it will be appreciated that this vessel is one which opens a new era in the history of shipbuilding and marine engineering. It is of interest to note that the weight of the Diesel engine machinery is—so the builders inform us—practically the same as that which would have been necessary had steam reciprocating engines or turbine propelling machinery been installed. With regard to the engineers required to work the ship, in addition to the chief engineer and his second, there are ten engineers for watch keeping, four electricians, eight craftsmen and day engineers, besides twenty-three men who act as greasers, donkey men and storekeepers. We are able to state that so far the Aorangi has had a very successful run on her long maiden voyage of over seven thousand miles. It is hoped at a later date to give some particulars concerning this voyage, and some extracts from the engine-room log.

In concluding these articles we desire to place on record our thanks to the owners and builders of the ship for the courtesy which they have shown in allowing us to inspect the machinery, and to be present at some of the trial runs.

THE Institute of Patentees is organising the third annual exhibition of inventions, at which prizes will be awarded, to be held at the Central Hall, Westminster, from Monday, June 8th, to Saturday, June 13th, inclusive.

New Waterworks for Kingston-upon-Hull.

THE Corporation of Kingston-upon-Hull about a year ago began to construct a new pumping station at Dunswell, which is about 4 miles from the city. The underground works are in the chalk, which is capped at the site with glacial drift, varying from 20ft. to 40ft. in thickness. The level of the ground is only some 4ft. above Ordnance Datum, and the rest level of the water from the chalk is practically at the surface of the ground.

The works comprise a pumping well, seventeen shafts, several bore-holes, and nearly a mile of adits, together with the necessary pumps and engines.

The pumping well is 19ft. square to a depth of about 110ft. below ground level. It is timbered, and lined from top to bottom with cast iron segmental flanged rings, 16ft. diameter, the space between the rings and the square timbered well being filled with cement concrete. The bottom of the well is of cast iron resting on concrete. Adjacent to the well is a penstock shaft connected by a 36in. pipe to the well lining. This shaft will be fitted with a sluice valve to shut off the water entering the well, in case the 36in. valve inside the well should become faulty.

There are seventeen shafts, in addition to the pumping well and penstock shaft. These shafts are lined with complete cast iron cylinders, 8ft. 6in. diameter, through the clays and sands overlying the chalk, and through the soft putty chalk to a depth varying from 20ft. to 45ft. The boring of the shafts is continued through the chalk to a depth of 107ft. from the surface to receive cylinders, 7ft. diameter, these cylinders being lowered into position and grouted up with liquid cement under water. The whole of the work on these shafts is carried out by boring, and all pumping during the sinking has thus been avoided. The floor of the adits, which are to be about a mile in length, will be at a depth of 100ft. below ground level. At the adit level withdrawable segments are used in the 7ft. cylinders, so that openings can be made for driving the adits. The adits will be 6ft. 6in. high by 4ft. 6in. wide. Ten of the shafts have been completed, fitted with their linings and grouted, and a further eight shafts, including the penstock shaft, are in course of construction.

The temporary pumping machinery made at the contractors' works, and now ready for delivery, will deal with 7,000,000 gallons of water per day, and it, with the pumping machinery already on the site, will bring the capacity of the temporary pumps to 11,000,000 gallons per day. Further temporary pumping plant will be provided as necessary to keep the water below the line of the adits, and when the plant is tested and the volume of water to be pumped to keep the water level below the workings has been ascertained, work will then be commenced on the driving of the adits connecting up the shafts and pumping well. It is possible that some 15,000,000 gallons of water per day will have to be pumped to waste. After the adits have been driven pumping will be stopped. From the bottom of each of certain shafts a 20in. bore will then be sunk to a depth of 600ft. from the surface. It will be seen by the above that a very large volume of water will have to be dealt with in driving the adits, but, on the other hand, the system adopted for boring the shafts, whereby all pumping during their construction was eliminated, effected a very great saving in fuel and labour.

The permanent pumping plant is already under construction. It will consist of two distinct units, each capable of raising and delivering into the district 5,000,000 gallons of water per day. The pumps are of the reciprocating three-throw bucket and plunger type. Each of the two pumps will be driven through double reduction gearing by means of a vertical "Brotherhood-Still" heavy oil engine, developing 350 brake horse-power at 300 revolutions per minute. Each engine has two cylinders, in which opposed pistons work on the two-stroke cycle. The bore of each cylinder is 13½in., and the combined stroke of the pistons is 22in. It is anticipated that at full load these engines will use no more than 0.36 lb. of residual fuel oil per brake horse-power per hour, and that when delivering water at the rate of 3500 gallons per minute against a total suction lift and delivery head of 250ft., the fuel required per 1000 gallons of water pumped will not exceed 0.59 lb. This, with fuel having a calorific value of 18,000 B.Th.U. per lb., will be equivalent to an overall thermal efficiency of 30 per cent.

The contractors for the whole of the underground works and permanent pumping machinery are A. C. Potter and Co., Dysart Engineering Works, Grantham, with whom are associated Peter Brotherhood, Limited, of Peterborough, as sub-contractors for the prime movers. The probable cost of the works outlined above is £260,000.

OFFICIAL figures compiled by the Dominion Bureau of Statistics indicate that for the whole of Canada over 14,000,000 cubic feet of natural gas was produced last year. The value of this was 5,875,150 dollars in 1923, showing the striking gain of over 4,500,000 dollars above the figures for 1910.

Welding Problems.

AT a meeting of the British Acetylene and Welding Association, which was held at the Old Colony Club, Leadenhall-street, London, on January 15th, Professor C. R. Darling, of Finsbury Technical College, gave a lecture on "Some Scientific Aspects of Welding."

Professor Darling at the outset explained that he was no good as a welder, and that all he wished to do was to try to put forward some of the ideas that occurred to one who was interested in welding but whose main occupation was of a purely scientific character. Confining his remarks to oxy-acetylene and arc welding, he said that it always seems to him to be a drawback that it is almost impossible to control the temperature. The temperature might be too hot or not hot enough, because it did not follow that by making the metals as hot as possible the best results were obtained. It would, therefore, be interesting to try and ascertain whether there was some special temperature at which the best results were obtained, and whether by using a temperature rather less than that of the oxy-acetylene flame the results would be better than by using the flame as it is ordinarily employed. That might be done by mixing acetylene with some gas of a less powerful character from the standpoint of the production of temperature. The oxy-hydrogen flame was not hot enough, generally speaking, from the fact that the temperature obtainable with it was limited because the steam produced by the union of the oxygen and hydrogen decomposed. The desired result might be obtained by the use of an oxy-oil flame. He had seen a certain number of experiments carried out on those lines, but they had never come to fruition. Nevertheless, it appeared a very desirable thing for someone to endeavour to solve this problem, although those engaged in the carbide industry might not think so. It would cheapen the process of welding, however, and in the end it would be better for industry altogether.

Then there was the very vexed and troublesome question of fluxes, the function of which it was not always easy to see. Undoubtedly they helped to make good welds, but the whole subject of fluxes wanted going into from a proper scientific point of view, so that we should not have so much of the mystery compound as we had at present. If the whole subject of the action of fluxes were to be properly tackled, there should be no good reason why we should not arrive at the best flux for certain welds for certain metals. The problem of the use of fluxes came out more prominently perhaps with arc welding than with oxy-acetylene welding. In the United States, the practice appeared to be to carry out arc welding without any fluxes at all. The truth of the matter seemed to be that an inferior welder could do good work with a flux where he could not do it with a bare electode, but that the really first-rate welder in the ordinary shops on straightforward work could make as good a job without a fluxed electrode as with it. In short, the use of welding compositions on electrodes was a concession to inferior workers, and if we trained better welders and did away with fluxes altogether, it would enable us very greatly to cheapen electrodes and lead to a much greater use of arc welding.

Among the welding problems upon which a great deal of investigation was needed were how the metal went from the electrode to the work, and what was the loss of ingredients in transit. Some of the metal dropped off, but some of it undoubtedly went as vapour, although what was exactly going on we did not properly know. In making an arc weld with a stick containing a good percentage of manganese, anything from 60 to 80 per cent. of the manganese was lost by oxidation on the way, and when it was desired, as with certain alloy steels, that the deposit should be of the same composition as the work, allowance had to be made for the loss by putting an extra amount of the desired constituent into the welding stick.

Another matter which was of growing importance, more particularly in spot welding, was the welding of the dissimilar metals. It was possible to weld together metals the melting points of which might differ by hundreds of degrees. For instance, nickel and molybdenum could be welded together, though the difference in the melting points was about 1200 deg. It was practicable, he believed, sometimes to weld cast iron by using alloys containing copper and other ingredients, instead of using an ordinary iron stick, the defect of which was that hard parts were formed, and it was very difficult to machine the weld afterwards. Therefore, it was getting customary certainly in American practice, to use alloys instead of iron in welding cast iron on to a different metal, and that might perhaps be a solution of a good many problems. In this welding of dissimilar metals, like copper and steel, there lay a big future open to the welding industries, because it was possible to obtain welds superior to those obtained by using the same material. Finally, Professor Darling explained the action of surface tension in connection with welding, and carried out a few experiments bearing on the same subject.

In the discussion which followed, the president, Mr. Charles J. Quirk, said that it seemed to him that whatever apparatus was used or whatever was done in welding, the chief thing to be studied and always recognised was the human element.

Mr. A. E. Plumstead asked what oil Professor Darling would suggest should be used with hydrogen for the purpose of enriching it for welding, and what percentage. He also inquired, with regard to hard spots in cast iron welding, whether they did not occur with the acetylene process, to which Professor Darling replied that he was referring to the electric process.

Mr. P. B. Liversidge mentioned that a number of experiments have been carried out in Switzerland and Germany with petrol and oxygen on what he believed was known as the Bergholt system, but his latest information, received about a month ago, was that it was absolutely a failure.

Mr. A. Stephenson said that heating in the weld, particularly in welding non-ferrous metals, was not entirely due to the heat of the flame. There were some people, specially in America, who were prepared to demonstrate the extra speed of the blowpipes they used, but to achieve that object they had found out a long time ago, that if there was a considerable excess of acetylene flame, a speed of welding could be obtained which altogether exceeded that which is reached by a properly adjusted flame, but the iron was burned. That was a thing which he met frequently years ago in every day work, particularly under piecework conditions, when the men found they could work much faster if they operated under conditions which burned the iron. He was not altogether in agreement with Professor Darling that fancy prices were paid for fluxes. He assured him that the market had now got down to a more or less competitive basis, so that it was only the best which had a market, and prices had to be based on a reasonable amount of production and on reasonable cost of materials, labour and overhead and selling charges. As to the experiments upon the action of fluxes, it must not be overlooked that they were lecture experiments in liquids in which the factors which entered into a weld did not operate. There were different conditions altogether in molten metals from what there were in liquids, and therefore the question of surface tension effects must bear a little modification from those which had been shown. There was an important point in connection with the flux-coated electrode and the bare electrode, and that was when our American friends started welding they did not start in the same competitive field that we did in this country and on the Continent. The gas welding industry was fairly well established, and reasonable and reputable work was being done in Europe and the adjacent countries, and America did not have to meet the same conditions. Consequently they made considerable progress with electric welding, but it was the fact that flux-coated electrodes were creeping in to a large extent now in America, especially for ship work and in the naval yards. The characteristic features of arc welding by bare wire and flux-coated electrodes were that, with the bare electrode, high-tensile strength and a reasonably metallic structure was obtained, but no ductility. Metal so welded would stand very little reverse torsional stresses. If, on the other hand, coated electrodes were employed under the same conditions and with the same metal, poor strength was obtained, but reverse torsional stresses were fairly high, and there was reasonable ductility. That was admitted in America as well as here, and it spoke for itself with regard to the utility of the flux coated or the bare electrode.

Mr. A. E. Shorter, as an advocate of welding with bare electrodes when possible, said that there were some welding plants with which it was almost impossible to maintain an arc with bare electrodes, while with heavily-coated electrodes it might be quite possible. Again, a very large number of jobs did not require an absolutely perfect weld, such as the building up of rail surfaces that only had to stand crushing stresses. He had been interested for a considerable time in the building up of tramway rails, and many thousands of inches of steel rails had been built up with 0.8 per cent. copper electrodes bare and uncoated, without a single failure. That was largely due to efficiency in the operation and the maintenance of a steady arc. Some months ago he made a thorough investigation into the possibilities of the oxy-petrol process, but the conclusion arrived at was that the heating value of that blowpipe was not nearly so high as that of the oxy-acetylene blowpipe.

Mr. C. Coulson Smith suggested that it would be an advantage to have flux-coated rods for oxy-acetylene welding, instead of the welder having to dip his rod into a tin every time. In order to prevent oxide getting into a weld would it be advisable to use kaolin or china clay, a composition of silica and alumina which, at the high temperature of the arc, would put a coating of silica on the line of the weld, that would be impervious to oxidation. A friend of his with Armstrong, Whitworth and Co. had used Monel metal in the welding of cast iron, and got good results, but was very reluctant to give away details.

Mr. A. Hoddle said that if fluxes were useless then every brass finisher to-day was working under a delusion, and yet he used a flux to exclude something he did not want to get into his joint, to clean his metal, and to facilitate the amalgamation of the two metals he was dealing with. A good deal of so-called welding was what he would call brazing, because a weld must be a perfectly homogeneous mass. With good welding rods there seemed no reason to go to the complication of trying to coat them.

Mr. W. J. A. Butterfield said that the traditional method of joining lead, especially where it was necessary to avoid electrolytic action, as in lead chambers, was to use a hydrogen or oxy-hydrogen flame, and we were told that we must have a very skilled craftsman who did nothing else, and that it was a life's study to learn the job. Professor Vernon Boys, faced with the problem of joining some very thin lead, mixed a very large proportion of carbon dioxide with the hydrogen, so that really he had a very low flame temperature. He wondered whether for certain classes of acetylene welding it might be useful to try to keep down the temperature of the flame when working with very thin metals, by the addition of perhaps carbon dioxide, or there might be some other diluent which would serve the purpose better.

Professor Darling, replying on the question of coated electrodes, said that if a man could do the work with bare wires he would be very foolish to spend a lot of money on coated wires, which would not do the job any better for the purpose in view. For certain special classes of work, the coated electrodes would be better, but for the ordinary run of shop repairs, &c., it appeared to be fairly well established that bare wires were quite good enough. He was interested to hear of the progress made with the use of the oxy-petrol flame. He remembered some work carried out in France in which hydrogen enriched by adding petrol was used, and it was claimed that good results were obtained, but he did not think petrol was the best material to employ.

Mr. Stephenson said that in 1912 he went over to Germany and watched experiments on oxygen and benzol, but that the net result was a weld three times as wide, very crystalline in structure, the rate of welding was one-fifth that of the oxy-acetylene, and, finally, the cost was about one and a-quarter times that of acetylene.

Professor Darling said that up to the present the thing was not a success, but it did not follow that that was the end of it. His experiments on surface tension really applied to welding, if the two metals were liquid. If the metals were in a pasty condition, then the experiments must be subject to considerable modification. He did not condemn fluxes entirely as being useless in every case, but maintained that there was no necessity to use fluxes

when they could be done without. If a set of investigations on welding with different types of metals were carried out so that we could arrive at the best flux for a particular metal, everybody would know what that flux was, and everybody could use it with safety. That would be a different state of affairs from that which now prevails. The whole thing wanted properly systematising scientifically, and until that was done there would be all kinds of curious compounds on the market which the scientific man really detected, because he desired to arrive at the truth.

SIXTY YEARS AGO.

SIXTY years ago the twin-screw system of propulsion for steamships was just coming into general esteem. In a leading article in our issue of January 20th, 1865, we recalled the fact that the system was first urged upon the attention of the Admiralty by Richard Roberts, who had but recently died, more or less in poverty, but that few were disposed to acknowledge even the practicability of his invention. Years afterwards Captain Symonds reintroduced the idea with improvements of his own, but was told by certain practical shipbuilders and engineers that a twin-screw vessel would neither steam nor steer. Captain Symonds continued, however, consistently to advocate the adoption of the principle, and ultimately it was recognised that it offered many advantages in the handling of the ship and the arrangement and working of its engines. At the date on which we wrote twin screws were almost universally acknowledged to be superior to a single screw in warships, and it appeared likely that they would soon obtain a decided preference for commercial ships. The change in their favour was produced, not only by the intrinsic merits of the system, such as the reduction of the stress on the stern of the ship when she was pitching, the possibility of steering the ship without aid from the rudder, and the fact that with twin screws it was practicable to dispense with outer bearings; their adoption was being practically forced upon shipbuilders and engineers by the necessity for reducing the size and weight of the engines. It was shown that the cylinders of H.M.S. Warrior, 112in. in diameter by 4ft. in stroke, could be replaced without loss of power by two sets 90in. in diameter with the same stroke, and that the indicated power would be the same if the speed were raised from 50 to 75 revolutions. Limitations to the size of the engines that could be placed within the hull of a vessel were inducing shipbuilders and engineers to seek some means of using lighter parts and working them at increased speeds. To secure that end the twin-screw arrangement was becoming more and more favoured. Incidentally, twin screws, it was argued, were advantageous in that the breakage of a propeller shaft would not reduce the vessel to impotency. It would seem that propeller shaft breakages were at that date of alarmingly frequent occurrence. In the Peninsular and Oriental Company's service in 1854 there were six breakages, in 1855 two, in 1856 seven, in 1857 five, in 1858 seven, and in 1859 five, and the average continued at the same high level up to the date of writing, one ship in every seven in the fleet breaking a screw shaft in the course of each year's working.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

INDIVIDUALISM IN LOCOMOTIVE DESIGN.

SIR,—Referring to Mr. Howsin's letter of January 3rd, I am not sufficiently learned in obstetrics to know whether one can "camouflage" a womb—though the classical instance of the "parturient" mountain, which produced a "ridiculus mus," is perhaps evidence that this sort of thing has been done!

But I am sorry that after my own past labours, culminating in the pains which produced the article under criticism, it should bear any suspicion that it has not said what it meant, or meant what it said.

Whether it is to be taken as a general attack on "locomotive superintendency" is for others to decide; but your correspondent seems to beg the real question at issue, and, incidentally, to support one of the contentions of the article.

It is unnecessary for him to ask our sympathy for men who have perhaps the most onerous duties of any profession in the country—torn by the cry of the traffic manager for power and more power; faced often with the necessity to reverse their predecessor's policy in locomotive design; and requiring every effort of statesmanship to grapple with the tyranny of trades unions. Few are more deserving of sympathy, but, obsessed with such cares, and "harassingly occupied in keeping time, the alpha and omega of their duties," according to Mr. Howsin, how can such men devote the time required for such a highly specialised subject as the detailed design of their locomotives?

Might they not be well advised to leave such matters to those who make it a life's business, or at least to consult and employ them more?

The most admirable of sea captains and engineers are not necessarily expert designers of the ships they have to drive and navigate, and the marvellous development of the marine engine in Britain is not due to the technical skill of the shipowners.

There is an immense mass of evidence to support any reasoned statement that "Individualism" in the sense in which I have used the word, has cost the home railways—and may cost the Argentine railways, too—very dear. The most striking example, on the largest scale, too, can be found in a study of the locomotive policy for many years on the late London and North-Western Railway, where, surely, thirty years ago "individualism" was at its height. Other evidences can be found in your own recent columns, in the reconstruction of a number of quite modern heavy engines designed at a time when thousands of successful engines of the same type were running at home and abroad.

Mr. Howsin, from his own experience, is aware that the locomotive builders can design a first-class article for foreign service. Surely they can do so equally well for conditions at their doors. It is, in truth, not only abroad—as Mr. Howsin suggests—that their products are urgently needed to-day.

I cannot do better than conclude by quoting from a spontaneous and quite unexpected correspondent who has just written to me out of a longer and larger experience than mine: "The position really amounts to a cleavage between railway engineers on the one hand, and private locomotive builders on the other—in this country, be it remarked. In my experience there is no such attitude in America, and on the Continent, between these two classes as one finds at home. . . . For many years, both the railway companies and the private builders and the industry generally in this country have suffered more perhaps from this cause than from any other. . . . You have approached a thorny subject by spreading out the bare facts for the observation of all concerned. . . ."

I heartily endorse my correspondent's conclusion "that it is to the interests of all to close up the gap, so that the railway companies and the private builders might work more closely together, as in America and Germany, for instance," and I submit, Sir, that the best way to approach the "mountains of prejudice and difficulty" still standing in the way—whether camouflaged or not—is by a presentation of facts.

Mr. Howsin gives us few, and I should not have inflicted a reply upon your readers had I not wished to remedy, rather than worsen, a regrettable state of affairs—to close a gap, rather than to widen it. I have at least the satisfaction of knowing that the frequent expression in private of the views set forth in your article has not so far cost the writer some highly valued friendships in the railway world.

January 19th. J. G. H. WARREN.

WASTE HEAT.

SIR,—In the course of the editorial pages in your journal of the 16th instant you remark on the possibilities of waste heat as a source of considerable supplies of electrical energy. In view of the great attention which has been focussed during the past few years on super stations and hydro-electric and tidal power installations, your comments are, I think, of great value in turning the attention of engineers to a source of power which has only been "nibbled" at up to the present.

There seems to be a general impression that water or tidal power is the cheapest source of electric energy; as a matter of fact, waste heat produces power at a much lower figure, as the capital charges on a complete waste heat recovery scheme are far less than those of water power installations with their expensive headworks. Furthermore, waste heat occurs in the manufacturing districts, *i.e.*, where electrical power is most required; hence transmission costs are lower.

As a concrete example the approximate estimate for the Severn barrage scheme is some 28 million pounds. Deducting 2½ millions for the railway and road bridge, this brings the estimate for the complete hydro-electric scheme down to 25½ millions, excluding transmission lines to the Midlands and/or London.

The average output over the tidal cycle is estimated at 200,000 horse-power per hour, *i.e.*, the capitalisation works out at £127 per horse-power. Now compare this with a typical waste heat recovery electric generating scheme on a much smaller scale, *i.e.*, even where the prime mover efficiencies are comparatively low owing to their relatively small size. The total capital outlay was approximately £27,000, and the steady output is 32,000 lb. of steam per hour or 1500 electrical horse-power. In this case the capitalisation works out at £18 per horse-power, *i.e.*, only some 14½ per cent. of the barrage scheme.

The figures for the river Severn proposal are taken from a recent paper given by Professor Miles Walker, and the figures on the waste heat plant are from a typical installation recently completed by my firm. In his paper Professor Walker shows that it should be possible to reduce the electrical cost of the Severn barrage scheme by 8 millions, which in turn reduces the total to 17½ millions; but even at this latter figure it works out at £87½ per horse-power.

It is not my intention to disparage the use of water or tidal power. National interests demand its full exploitation, and the labour item alone on such projects being a heavy one, is a valuable set-off against unemployment. The above comparison simply shows that the less spectacular and often disparaged waste heat recovery scheme is an excellent economic proposition.

As a typical broad instance it is interesting to note that the full utilisation of the waste heat from the gas undertakings of London and Greater London on a proper basis would result in sufficient surplus electrical energy—after all works requirements were satisfied—to operate London's Underground Railways. In our big industrial centres the presence of coking plants and furnaces of all types makes the proposition even more attractive as a local source of cheap electricity.

W. GREGSON, Major (late R.E.),
General Manager and Director,
Spencer-Bonecourt, Limited.

London, January 20th.

IRON ORE RESOURCES OF SOUTH AFRICA.

SIR,—My attention has been drawn to an article in your issue of January 9th, entitled "German Capital for Steelmaking in South Africa."

This article states that "It must be remembered that, although it is customary to refer grandiloquently to the 'enormous' iron ore resources of the Union of South Africa, there are not 30,000,000 tons of iron ore, really high grade and suitable for the manufacture of iron and steel, so far proved to exist." This might create a wrong impression.

The iron ore resources of the Union of South Africa are enormous, and our company alone has at its disposal 109,000,000 tons of iron ore containing from 48 to 52 per cent. of metallic iron, and 45,900,000 tons of an exceedingly pure ore, containing on an average 66 per cent. of metallic iron. The whole of this quantity is suitable for the production of steel of a good quality.

P. A. DELFOS,
Managing Director, S.A. Iron and
Steel Corporation, Limited.

Werksgasthaus, Oberhausen, Rhineland,
January 16th.

THE WHITWORTH SCHOLARSHIPS.

SIR,—In an interesting paragraph on the above subject in your issue of the 19th ult., it is suggested by your Manchester correspondent that the age limit of candidates should be extended to twenty-three. As, however, of the six successful candidates for 1924, four were of the age of nineteen and two of twenty, the present limit, twenty-one, seems quite ample.

A. D. OTTEWELL, Wh. Sch. (1877).

Derby, January 17th.

The Institution of Civil Engineers

OCTOBER EXAMINATIONS, 1924.
PASS LIST.

Preliminary (44).—A. Adlington, E. M. Austen, N. C. C. Barrell, H. C. Barrett, W. H. Burton, C. N. Butler, G. Butters, F. Collins, R. Cornish, D. W. Currie, R. E. Downes-Shaw, E. Edwards, D. R. Errington, G. L. Goulden, E. A. Haines, R. A. Haworth, F. F. Hixson, F. F. Horton, C. M. Howard, J. Hurrell, C. S. Jackson, C. C. Knowles, G. W. B. Lowson, B. C. McPherson, G. J. Mair, I. McL. Malcolm, L. L. Meadowcroft, B. Muller, F. H. Petty, G. M. Pickard, B. Plunkett, E. T. M. Rees, F. J. A. Richardson, L. W. Rogers, N. O. Russell, R. T. Saunders, W. J. Scott, W. O. Skeat, L. G. Snow, R. Spence, W. Struthers, J. P. Thornton, C. D. Trinder, W. O. Wright.

ASSOCIATE MEMBERSHIP (226).

Whole Examination (Sections A, B, and C) (15).—W. H. Cadwell, O. J. Doidge, G. Edmond, P. W. Fryer, E. W. George, M.C., H. M. Gibb, C. Langbein E. G. Mitton, A. Murray, H. J. Nowlan, E. C. M. Reid, E. C. Smith, J. R. Sutton, A. E. Tuffley, C. A. J. Turlot.

Sections A and B only (18).—A. Aitken, H. G. Bloss, W. G. Donaldson, S. L. Engel, F. A. Hardy, C. H. McL. Hawk, D. W. D. Hutcheson, A. S. Johnston, E. R. McKillop, F. R. MacRae, D. E. S. Mason, J. B. R. Mason, W. G. Miles, G. B. Miller, J. Muirhead, H. A. W. O'Connor, W. E. Puddy, J. Sinclair, M.C.

Sections A and C only (4).—R. L. Clack, R. Crooks, J. A. McK. Donnelly, J. Walker.

Sections B and C only (9).—N. P. Angus, M. El Zarka, G. C. Griffith, J. T. Harrison, A. J. King, J. Manson, G. A. K. Simmers, J. R. Thackeray, W. L. Williams.

Section A only (41).—A. F. Allen, O. W. Berry, H. M. Boot, L. Bown, H. S. Boyes, D. V. Buck, H. F. Bull, W. Butterworth, H. K. Cox, I. N. Deakin, R. H. Edwards, J. H. Ellacott, A. R. Entrican, T. C. S. Haslam, D. E. Holden, J. Y. Hughes, E. L. Kelting, C. R. Kinton, J. Kirby, F. X. Koenig, E. B. J. Lanyon, F. Lee, F. Levy, C. P. Lowe, F. C. T. Nutter, C. C. Parkman, A. M. Rosie, jun., G. G. E. Scribante, J. Sewell, J. A. Sherwin, A. R. Smee, W. Sowerby, I. H. Strachan, W. K. Taylor, A. Tillotson, F. W. D. Timson, M. J. Wardle, A. C. Webber, C. E. Whitaker, T. M. Wright, D. Yorke.

Section B only (25).—T. G. G. Beck, H. G. Bengough, M. G. Bucknall, J. S. Carmichael, N. W. Carr, H. H. Facey, G. Gray, jun., J. V. Hall, S. Hazel, B. Hodgson, J. M. M. Howat, C. C. Kirby, N. K. Littlejohn, C. G. Lonax, D. S. G. Marchbanks, W. E. Marsh, A. V. Martin, A. W. Morrison, S. G. Reilly, J. I. A. Scribante, A. F. Simpson, H. C. Smith, C. S. Sparrow, E. A. M. Walker, A. C. Wardle.

Section C only (114).—P. R. Alderman, D. A. Alves, A. Anable, B.A. (Cantab.), J. F. Anderson, T. A. Anderson, J. G. Arthur, B.Sc. (Birmingham), T. J. H. Balden, D. R. Balfour, B.Sc. (Durham), G. S. E. Barker, D. J. Barnes, G. McL. Beck, G. B. Bell, B.E. (New Zealand), W. L. Bell, P. S. A. Berridge, W. E. C. Bird, E. C. Boden, E. S. S. Bowman, B.A. (Oxon), C. Bown, J. D. Bush, B.Sc. (Birmingham), M. A. Butler, G. L. Carpenter, J. R. Caseley, B.Sc. (Eng.) (Lond.), O. H. Chilton, C.V. Clarke, J. Cohen, B.Sc. (Cape), G. H. E. Collins, G. V. Cox, R. L. M. Dick, B.Sc. (St. Andrews), B. V. Dilley, J. N. Dubash, R. J. Edmonds, R. W. Edwards, I. H. El Gamal, F. Ewbank, J. D. Farmer, G. S. Findlay, J. K. Fisher, B.Sc. (Eng.) (Lond.), E. A. Gardiner, B.Sc. (Eng.) (Lond.), W. J. C. Garrard, R. C. Gowthorpe, B.Sc. (Manchester), R. Grant, B.Sc. (Edin.), G. S. Graver, L. K. Greene, B.Sc. (McGill), I. H. Hainsworth, W. P. Haldane, B.Sc. (Glas.), G. M. Hall, P. H. V. Hanitsch, H. Hardwick, G. E. Hardy, H. Hefny, A. M. Helmy, K. J. C. Hill, B.Sc. (Edin.), J. E. Holmstrom, B.Sc. (Eng.) (Lond.), R. V. H. Howe, B.Sc. (Eng.) (Lond.), R. Hudson, A. C. Jack, B.A. (Oxon), M. R. James, C. M. Jennings, E. M. R. Jones, B.Sc. (Eng.) (Lond.), H. M. Kirkland, B.Sc. (Edin.), V. D. Kotharc, W. T. Langbein, E. C. Lightbody, M.C., F. J. Locke, R. H. Lovatt, F. W. Luke, R. MacDonald, A. D. MacKay, B.Sc. (Cape), A. D. McLeish, J. MacPherson, jun., J. J. Maguire, B.E. (National), D. S. Matheson, B.Sc. (Glas.), H. S. Matthews, P. R. Meredith, B.Sc. (Edin.), M. I. Mohamed, T. V. More, B.Sc. (Birmingham), E. E. Morgan, M.C., C. F. Newton, J. H. A. Patton, B.A., B.A.I. (Dublin), J. P. Pike, P. Porteous, F. A. Rayfield, J. Reid, A. B. Richards, D. L. C. Robertson, B.Sc. (Glasgow), J. T. Robinson, W. R. Robson, P. C. Ruthven, B. E. Sadler, B.Sc. (Eng.) (Lond.), A. Scott, D. H. Scott, A. Selvadurai, W. T. Shaddock, B.Sc. (Durham), E. M. Shipman, B.Sc. (Eng.) (Lond.), J. U. Sinclair, B.Sc. (Edin.), W. J. Sinclair, S. J. Slaughter, M. G. R. Smith, B.Sc. (Bristol), R. Speight, D. D. Stedham, C. R. A. Stewart, D. J. Stott, C. G. Sturt, A.F.C., B.Sc. (Eng.) (Lond.), E. C. Thorburn, M.C., W. Thorburn, M.C., B.Sc. (Edin.), J. Venters, B.Sc. (Edin.), J. D. Wall, M. Ward, A. F. Webster, R. M. Wilkinson, M.C., A. W. Wilson, A. N. Wilson, B.Sc. (Bristol), C. G. Wilson, M.M., E. Wiltshire.

SALARIES OF ENGINEERS.

WE reprint the following paragraphs from the Circular of Information issued to members of the Society of Technical Engineers. The question and answer referred to therein have not yet been published in the parliamentary papers.

"*Government and Engineers' Salaries.*—The Society has recently taken action with regard to the position adopted by the Air Ministry in offering salaries of £3 a week plus Civil Service bonus to qualified engineers with the training of a university degree and practical experience in works and drawing-office. THE ENGINEER and *Engineering* published letters of protest from the S.T.E. on the subject following their publication of the Air Ministry's advertisement. We also took the matter up with the Air Ministry direct, as well as drawing the attention of the Royal Aeronautical Society and the Institution of Aeronautical Engineers to it. On December 31st the Air Ministry sent us a copy of its reply to a question asked in the House of Commons by Mr. H. G. Williams, as follows:—

"*Mr. Herbert Williams*—To ask the Secretary of State for Air if he is prepared to reconsider the terms offered in an advertisement published in several engineering papers for an assistant engineer for the Royal Aircraft Establishment, Farnborough, namely, £3 a week and Civil Service bonus for a professional man with the degree of Bachelor of Science and several years' practical professional experience.

"*Answer.*—The terms in question are offered as a commencing salary only to test assistants, not to assistant engineers, and candidates who prove their worth have opportunities of early advancement to a higher rate of pay. I do not consider that in the circumstances they need revision.

"This is not a very frank answer on the part of the Air Ministry. Their reply to Mr. Williams suggests that the salary in question is offered only to very junior men, while the Farnborough advertisement shows that those taking up the post must have had several years' practical engineering experience. The matter cannot be left where it is. The Institution of Aeronautical Engineers is moving with regard to it. By following up the question it is hoped that something may be done to bring about a more enlightened policy on the part of this Government Department."

High-pressure Cables.*

THE essential feature of the author's hexaphase system as devised exclusively for underground operation was the utilisation of the two outer conductors, in a system of triple concentric cables, in such a way that part of the load to be transmitted was efficiently put through the external conductors, while, at the same time, the benefits in the direction of increased voltage of transmission consequent upon the employment of intersheaths were fully realised. The author has, however, had impressed upon him the necessity of being able to connect up readily with ordinary overhead extra-high-voltage trunk transmission lines, and, in fact, to have the underground cables only at the beginning and end—and, perhaps, in the middle—of such lines, and he has therefore cast about for a means whereby the benefits of the hexaphase system could be taken advantage of, while, at the same time, the difficulties of connecting up with ordinary three-phase E.T.H. overhead lines could be overcome.

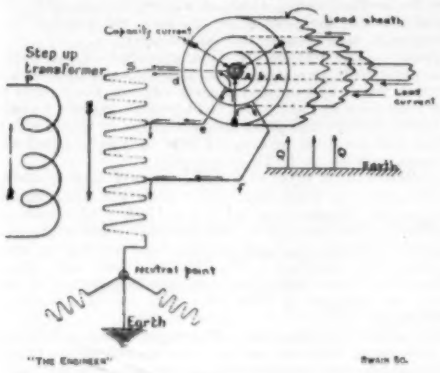


FIG. 1

The arrangements described in Fig. 3 of the paper contributed by the author to this Institution a year ago—here reproduced, for convenience, as Fig. 1—would have been practicable but for the very great disadvantages already pointed out by him; first, that only an inappreciable amount of the power to be transmitted can be passed through the outer intersheaths of the cable, and, secondly, that the capacitance currents required to be transmitted through the outer intersheaths are so very great over a line of any considerable length as to render the system unworkable.

The author has, however, made a great advance by passing the charging k.V.A. for the distant parts of the line through the central core only and at the very highest pressure and feeding them into the outer intersheaths where required. In this way the capacitance current required to be put through the outer intersheaths is greatly reduced. Consequently, the cross-sectional area of the copper in these outer intersheaths can also be very considerably reduced, and the fact that they cannot be employed for the transmission of power becomes, therefore, of secondary importance.

The advantage remains, moreover, that only three overhead conductors are necessary, or six if the line is duplicated. The author considers that in the matter of the transmission of power at really high voltages, such as 150,000 volts, the employment of three-core cables of the ordinary type is quite impracticable.

There is no question that single-core cables can be made for a pressure of 100,000 volts in a form very much more convenient to handle than three-core cables, in which the diameter runs up to 6in., and it is further demonstrable that they can better part with their heat than can the three-core cable. Moreover, a failure of any one core to earth does not necessarily precipitate a short circuit between phases, as is pretty certain with a three-core cable.

In an example that has been worked out, a limiting potential gradient of 50 k.v./cm. has been assumed as the basis, and it has also been assumed that it is undesirable to have a greater depth of paper than $\frac{3}{4}$in. and a greater overall diameter than the corresponding triple-concentric cable. The writer believes that even this thickness of insulation is probably a bit unsafe, for mechanical reasons. The diameter of the core has been expanded by means of a worming of jute of about $\frac{3}{4}$in. diameter in order to reduce the potential gradient to the said value, and the overall radius of the copper core is 1.5 cm., while the radius underneath the lead sheathing is 3.4 cm.; a drawing of the cable is given in Fig. 4. With the above dimensions the cable will just operate without excessive stress at 104,000 volts between phases, i.e., 60,400 volts per phase. The capacitance of this cable has also been worked out, and comes to 0.35×10^{-6} farad per mile, which with 40 miles of cable and 60,400 volts per phase gives a capacitance current (at 50 periods) of 266 ampères per phase. Taking the dielectric power factor at 0.01, the dielectric loss per cable per 40 miles amounts to 160.5 kilowatts, which on three cables totals 481 kilowatts. With 50,000 kilowatts transmitted this represents a loss of 0.95 per cent.

The difference between the dielectric loss of the single-core cable and that of the triple-concentric cable is only, roughly, 1 per cent., whereas the gain in voltage is 50 per cent., which, of course, means that the section of the overhead line for equal percentage drop can be halved. Another way of looking at it would be to say that if the dielectric in the single-core cable were to be put under the same pressure as the triple-concentric cable, the dielectric loss would be no longer 0.95 per cent., but 3.80 per cent. Another feature to be borne in mind is—and this will be seen by a reference to Fig. 2—that, whereas with the single-core cable a capacitance current of 133 ampères has to be transmitted through the overhead line to the distant end of the line in order to charge the dielectric, a current of only 59 ampères has to be similarly supplied with the triple-concentric cable. Moreover, while the 133 ampères are supplied under 100,000 volts, the 59 ampères are supplied at 150,000 volts, and, of course, the percentage of voltage drop in the overhead line due to capacity current is very much greater in the one case than the other.

The author feels that it is unnecessary to say more; he considers the case quite proved that the inherent disabilities of the triple-concentric cables are, on the whole, no greater than those of single-core cables.

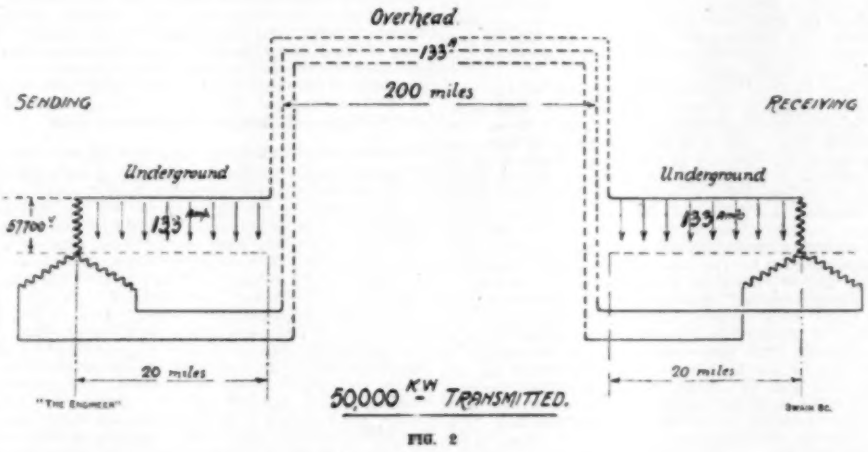


FIG. 2

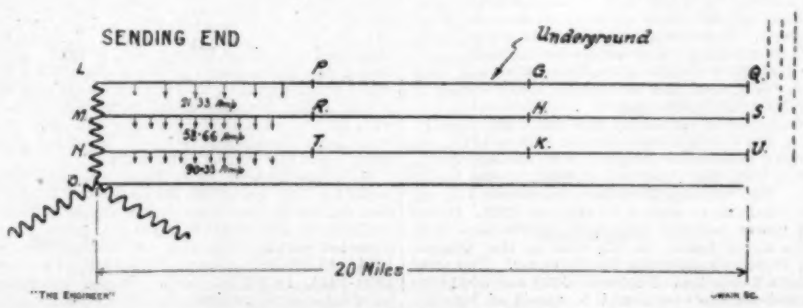


FIG. 3

TRIPLE-CONCENTRIC CABLES FOR USE WITH THE COMPENSATED THREE-PHASE SYSTEM.

As is already known, the author has had a length of 100 yards of triple-concentric cable made and subjected to very complete tests, both for dielectric hysteresis and breakdown pressure, and the results are in every way very gratifying. A cross section of the cable is given in Fig. 5. This cable, it may be stated, was designed for use with the hexaphase system—already described before this Institution—in which the voltage of transmission (between outers) was to be 150,000 volts. It was intended that between each two cores there would be 30,000 volts, and

FIG. 4

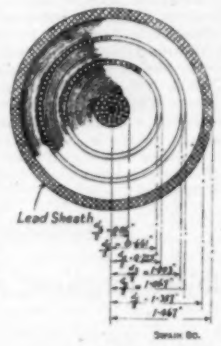


FIG. 5

the cable has been tested under these conditions. The capacitance current, as actually measured, agreed very closely with that calculated by the author, and the measured capacitance of the cable also agreed therewith, and the dielectric losses came out, in fact, better than estimated, the power factor of the innermost dielectric being as low as 0.006 at 50 periods and when working at 50 per cent. over normal pressure (and at 38 deg. Cent.).

As regards breakdown tests on the cable, quite a few have now been made, and in more than one case the cable has stood up to:—

180 k.v. between the innermost core and the intermediate core for fifteen minutes;

120 k.v. between the intermediate core and the outermost core for fifteen minutes;

120 k.v. between the outermost core and the lead sheath for fifteen minutes.

In one case these voltages failed entirely to break down the cable, even though maintained for fifteen minutes.

The above corresponds to 420,000 volts between the central core and the lead sheath, which again corresponds to 725,000 volts between phases. Allowing a factor of safety of 5, this would permit of a working pressure of 145,000 volts. The author thinks, however, that it will be agreed that a factor of safety of 5, with a voltage of 145,000, is higher than would be expected on, for example, a 100,000-volt three-core cable, since this factor of safety is not materially exceeded even in 30,000-volt cables.

Fig. No.	Description.	Heating factor in terms of 33,000-volt cable.	Dielectric factor of safety if worked at 33,000 volts apart from heating factor.	Ditto discounting for heating factor.	Relative saving in overh'd copper in terms of a 33,000-volt cable.	Relative advantages over 33,000 volts combining all three features.	Relative lengths on a drum.
2	66,000 volts three-core (armoured) with double "belt"	2.7	10	3.71	4.0	14.8	0.730
3	Ditto with $\frac{1}{4}$ "belt" (armoured)	2.24	10–8	4.47–3.57	4.0	17.9–14.3	0.814
4	"Paris" type cable (armoured)	2.87	10–6	3.49–2.09	4.0	13.9–8.3	0.730
5	100,000 volts 3-core (armoured) with $\frac{1}{4}$ "belt"	4.65	15–12	3.70–2.96	9.0	33.3–26.6	0.476
6	Single-core 104,500 volts cable (unarmoured)	0.848	Say, 13–11	15.3–13.0	10.0	153–130	1.00
10	Triple-concentric 150,000-volt cable (unarmoured)	1.55	22	14.2	20.5	291	1.00

In Fig. 3 are shown the capacitance currents required to operate the author's cable, allowing 20 miles of underground cable at each end of the line. This may seem to some to be a little bit extravagant, but it has to be borne in mind that there may be branches at either end of the line (whether from a couple of generating stations in a big city or to a couple or more of sub-stations in another big city at the receiving end of the line), and in any case there is the possibility that a portion of the line—in this country, at any rate—may have to be put underground, along the middle of this length, where it traverses some big town or towns. The estimated length of 20 miles is therefore none too high.

The table given above has been prepared in order to summarise the various conclusions reached in the paper. In the third column is given the "heating factor," which term merely conveys a numerical relative indication of the calculated temperature differences obtaining, for a fixed current density, between the core and the lead sheath of the various cables considered in the paper. In the fourth column it is assumed that all the cables are worked at the lowest pressure—33,000 volts—and the "factor of safety" is assessed on that basis. The rating has been put in this form for the following reason:—It may be said, "What is the good of going in for such high pressures, when they are so rarely wanted?" The reply is that there is none

* Abstract of a paper read before the Junior Institution of Engineers by Major A. M. Taylor.

too large a factor of safety in present cables, and if a cable designed for, say, 150,000 volts can be used for, say, 100,000 volts, then we have increased the factor of safety by one and a-half times the original value, i.e., a factor of safety of 5.0 becomes 7.5. Column six of the table is undoubtedly most important, as the cost of the whole overhead line is directly affected thereby.

It will be observed from column eight that the number of joints per mile, in the case of the 100,000-volt three-core cable, is more than double that in the single-core or the triple-concentric cable, and that in the case of the 66,000-volt three-core cable the number of joints per mile is roughly 33 per cent. greater than with single-core cables.

The table does not do full justice to the advantages of higher voltage, in that the effect of higher voltage upon the regulating properties of the line is not exhibited therein. This is a matter of the greatest importance, the inductance of the line being far more difficult to neutralise than the purely ohmic resistance. It should have been pointed out that the percentage of reactive drop in the line varies inversely as the square of the voltage employed. Hence with 150,000 volts the percentage reactive drop is quartered, as compared with 100,000 volts, a very important gain. The fact that the dielectric loss and probably the dielectric strength varies as the square of the applied voltage is ignored in columns 4 and 5.

Where it is desired to lay the transmission line entirely underground, increased power to the extent of 75 per cent., or even 100 per cent., can be put through an equal number of cables to that required for the compensated three-phase system. This point is well worth bearing in mind where the distance of transmission is not very great, as, for example, where it is required to transmit from one side to the other of a big city, and where, owing to congestion in the underground space available, every additional cable is of moment.

Lloyd's Register: Annual Summary.

LLOYD'S annual summary of the mercantile shipbuilding of the world for the year 1924 has just been published, and following our usual custom, we give below a *précis* of its contents. It will be remembered that this summary does not include warships, and that it takes into account only merchant vessels of 100 tons gross and upwards that were launched in 1924, whether they were completed during the year or are still under construction. Sailing vessels fitted with auxiliary power are included with steamers or motor vessels, according to type of engine. Returns are not available as regards Germany and Austria-Hungary for the war period (1914–18), nor as regards Germany for 1919 and 1920.

GREAT BRITAIN AND IRELAND.

Particulars of Total Output.—During the year 1924 there were launched in Great Britain and Ireland 494 merchant vessels of 1,439,885 tons—viz., 423 steamers of 1,195,216 tons, 50 motor ships of 237,458 tons, and 21 barges of 7211 tons. All these vessels are built of steel, with the exception of two composite vessels, of 242 tons each. Not a single sailing vessel was launched during the year. The output for 1924 exceeds by 794,234 tons the figures for 1923, which, apart from the war year 1916, were the lowest recorded during the thirty-two years 1892–1923. The present total represents no less than 64.1 per cent. of the world's output for 1924, as compared with 39.2 per cent. in 1923, 41.8 per cent. in 1922, and 58 per cent. in 1913.

Nationality of Vessels Launched.—Of the tonnage launched during the year, 1,218,944 tons are for registration in Great Britain and Ireland, and 220,941 tons—under 15½ per cent. of the total tonnage—are for owners residing abroad or for sale. This percentage compares with less than 3 per cent. in 1923, 26 per cent. for 1922, and an average of over 22 per cent. for the five pre-war years 1909–1913.

Size and Type of Vessels.—The returns for 1924 show that 75 vessels of between 5000 and 10,000 tons each and 16 vessels of 10,000 tons and upwards were launched. The following are those of 15,000 tons and upwards:—

	Tons.		Tons.
Statendam ..	28,150	Aorangi	17,491
Minnetonka ..	21,998	Gripsholm ..	17,000
Oronsay ..	20,001	Rampura ..	15,580
Orama	19,777	Cathay	15,000
De Grasse ..	17,962	Comorin	15,000

The above are the largest vessels launched in the world during 1924, none of the vessels launched abroad reaching 15,000 tons. Excluding vessels of less than 1000 tons, 13 vessels of about 65,000 tons, for the carriage of oil in bulk, were launched during 1924. Of them, 9 vessels of about 50,500 tons were built on the Isherwood system of longitudinal framing. The tonnage of steamers fitted for burning oil fuel launched during the year amounts to about 270,000 tons. The returns include a number of vessels designed for channel, coasting, fishing, towing and harbour service, and other special purposes. The average tonnage of steamers and motor ships launched during the year was much lower than usual, viz., 3029 tons. If the vessels of less than 500 tons are excluded, the average is increased to 3777 tons, as compared with 3805 in 1923, 5186 in 1922, 4602 in 1921, and 4387 in 1920.

Vessels Fitted with Turbines.—Further progress was recorded in the use of steam turbines during 1924, when 17 vessels with an aggregate tonnage of 202,982 were launched, which will be fitted with this method of propulsion, and all of them will have geared turbines. It may be stated that of the vessels of 10,000 tons and upwards launched during the year, 9 are to be fitted with turbines.

Vessels Fitted with Internal Combustion Engines.—The number and size of vessels fitted with internal combustion engines is steadily increasing. During 1919 the tonnage of such vessels launched was 32,936 tons, while in 1922 it amounted to 87,244 tons; and during 1924, 50 motor ships of 237,458 tons were launched, 23 of them being of 5000 tons and upwards, the largest being the Aorangi, of 17,491 tons, and the Gripsholm, of about 17,000 tons. These figures include one vessel, of 3830 tons, with electric motive power—oil engines being employed to drive the generators which supply the power to the propelling motors—and one of 5994 tons, fitted with "Scott-Still" combined oil and steam engines.

Output of Leading Ports.—The Clyde district occupies first place amongst the shipbuilding centres, showing an output of 532,072 tons. Then follow the Tyne, 275,672 tons; the Wear, 194,075 tons; the Tees, 161,511 tons; and Belfast, 105,390 tons. The largest increase, as compared with 1923, took place on the Clyde, the figures for which were 358,871 tons higher than in the previous year. The increase on the Wear amounted to 142,514 tons, and the increase on the Tyne to 138,264 tons, while at Belfast a decrease of 22,036 tons took place.

Progress of Shipbuilding During the Year.—As regards the movement of the shipbuilding industry during the course of 1924, Lloyd's Register quarterly returns show that at the opening of the year 1,395,181 tons were under construction in Great Britain and Ireland. These figures, apart from June and September, 1923, are the lowest since March, 1915, and show a reduction of 2,403,412 tons as compared with the record reached at the end of March, 1921. The returns issued during 1924 showed an increase at the end of March and again at the end of June, when 1,516,746 tons were being built. During the last two quarters of the year, a decided decrease took place, and on December 31st, 1924, the tonnage under construction in Great Britain and Ireland amounted to 1,296,971 tons, or 98,210 tons less than twelve months earlier. It should, however, be stated that while at the end of 1923 the totals included about 164,000 tons on which work was suspended, at the end of 1924 such tonnage had been reduced to 60,000 tons. Notwithstanding the above consideration, as the orders for new vessels—judging by the tonnage commenced, as shown in Lloyd's Register quarterly returns—have in no way kept pace with the tonnage launched, and have lately decreased, any marked improvement in the shipbuilding industry can hardly be expected in the immediate future.

OTHER COUNTRIES.

Particulars of Total Output.—There were launched abroad during the year 430 merchant vessels of 807,866 tons, 266 steamers of 503,727 tons, 99 motor vessels of 264,340 tons, and 65 sailing vessels and barges of 39,799 tons. The figures show a decrease of 189,664 tons, as compared with those for 1923, and of 4,716,241 tons, as compared with 1919—the record year—and they are 592,863 tons lower than those for 1913, during which year the highest pre-war total was reached.

Size and Type of Vessels.—The returns for the year include 29 vessels of between 4000 and 6000 tons each; 16 of between 6000 and 8000 tons; 12 of between 8000 and 10,000 tons; and 5 of over 10,000 tons each, the largest being the steamer D'Artagnan, of about 14,700 tons, launched at Bordeaux. There were launched during the year 15 vessels of a total tonnage of 81,668 to be fitted with turbines, the great majority of which are geared turbines. Of these vessels, 10 are of between 5000 and 8600 tons each. Excluding vessels of less than 1000 tons, the output abroad for the year also comprised 5 steamers of about 25,169 tons built on the Isherwood system of longitudinal framing. Including 2 of these vessels of about 12,000 tons, there were launched during the year 18 vessels of about 51,000 tons for the carriage of oil in bulk. During 1924 there were launched 99 vessels of 264,340 tons to be fitted with internal combustion engines, as compared with 81 of 138,796 tons in 1923. Twenty-seven of those launched during the year are of over 4000 tons each, including 11 in Germany and 4 each in Denmark and Italy; the two largest being of about 13,600 tons each, built in Germany. The total figures include a few sailing vessels fitted with auxiliary power. Amongst the motor ships launched in the United States during 1924 were 4 vessels, with a total tonnage of 1567 tons, which will have electric drive, oil engines being used in conjunction with electric motors. The tonnage of wood vessels included in the year's total was 19,290 tons, as compared with 13,974 tons in 1923, and 1,145,582 tons in the war year 1918, when the tonnage of wood vessels launched amounted to 28 per cent. of the total output. The totals for sailing vessels and barges included a very large proportion of craft which cannot be described as real sailing tonnage, this latter amounting to less than 30 per cent. of the total tonnage given under the heading of "Sailing vessels and barges." The countries in which the largest output took place during the year under review were Germany, the United States, Italy, France, Japan, Denmark and Holland. The totals for these countries amount to 677,108 tons, and account for 83¾ per cent. of the total output abroad.

Germany.—During the year under review, 116 vessels of 193,952 tons were launched in German yards. For the purpose of convenience of comparison with the output of previous years, these figures comprise the 8 vessels of 18,839 tons launched at Danzig. As compared with the output for 1923, the present figures are 164,321 tons less, but they, nevertheless, represent 24 per cent. of the total output abroad during 1924. These figures do not include a single vessel to be fitted with steam turbines, they comprise, however, 29 vessels of 99,741 tons to be fitted with oil engines. This tonnage equals about 37¾ per cent. of the total motor tonnage launched abroad during the year. The totals include 9 vessels of between 4000 and 6000 tons, 3 of between 6000 and 10,000 tons, and 3 vessels of between 10,000 and 13,628 tons.

United States.—The output for the year 1924, namely, 139,463 tons, was 33,354 tons lower than during 1923, and about 3,936,000 tons less as compared with the record year of 1919, and, with the exception of 1922, is the lowest since 1897. The tonnage launched represents 17¼ per cent. of the total output abroad for the year 1924. Of the steam and motor tonnage launched, 49,308 tons were built on the Great Lakes, 45,652 tons on the Atlantic Coast, and 11,967 tons on the Pacific Coast. The total figures include 2 steamers of between 6000 and 8000 tons each launched on the coast, and 5 vessels of between 8000 and 8877 tons launched on the Great Lakes. The motor tonnage launched in the country during 1924 amounted to 39,333 tons, and the tonnage of oil tankers, of 1000 tons and upwards, to 16,197 tons. The totals also include, as previously stated, 5 vessels with a total tonnage of 1567 tons which will have oil engines in conjunction with electric motors for the final drive.

Italy.—The total figures for this country—82,526 tons—are 16,003 tons higher than those for 1923. Six vessels of 32,557 tons were launched in the Trieste district, while during 1923 the output of that district only reached 7515 tons. The totals comprise 12 vessels of between 5500 and 8500 tons each. Six turbine-engined vessels with a total tonnage of 38,964 tons were launched, and 6 motor ships of 28,708 tons.

France.—The output for the year—79,685 tons—was 16,959 tons lower than the total for 1923, and is nearly 58,000 tons below the average output for the three pre-war years 1911–1913. The total figures include 4 steamers of between 5000 and 10,000 tons each, and 2 steamers of above 10,000 tons, of which the D'Artagnan, 14,700 tons, was the largest vessel launched abroad during 1924. No vessels fitted with turbines or with oil engines were launched in this country during the year.

Japan.—The output for this country—72,757 tons—was practically the same as in 1923. As compared with pre-war years, the present output exceeds the figures for any year prior to 1914. The 1924 totals comprise 4 vessels of between 5600 and 8600 tons each, one of which will be fitted with turbines, and one of 5600 tons to be fitted with oil engines.

Holland.—The total tonnage launched during 1924—63,627 tons—is 2000 tons lower than the 1923 figures, and is the lowest recorded since 1909. As usual, the figures for this country do not include vessels exclusively intended for river navigation, the total tonnage of which vessels often reaches a high figure. The only vessels launched of over 4000 tons were one motor ship of 4647 tons, one steamer of 7500 tons, and one motor ship of 9500 tons.

Scandinavian Countries.—The total tonnage launched in Denmark, Norway and Sweden amounted to 120,287 tons, which total is 8071 tons higher than the output for 1923. In Denmark there was an increase of 14,458 tons, and in Sweden of 11,093 tons, while in Norway there was a decrease of 17,480 tons. The total figures include 6 motor ships of between 4100 and 6873 tons, while the largest steamer launched in these countries is of less than 2900 tons. The total tonnage of the vessels fitted with internal combustion engines launched in these countries during 1924 amounted to 64,000.

British Dominions.—The total tonnage launched in all the British Dominions overseas during 1924, namely, 44,879 tons, is about 3600 tons more than in 1923. Of the total figures, 15,864 tons were launched in Canada, 12,690 tons at Hong Kong, and 11,751 in Australia. The totals include three vessels, of over 3000 tons each, viz.:—The Ferndale, of 9686 tons, built at Sydney, N.S.W.; a steamer of 7900 tons and one of 7164 tons, built at Midland, Ont., and Collingwood, Ont., respectively.

PROGRESS OF SHIPBUILDING ABROAD DURING THE YEAR.

Dealing with the combined totals for the work in hand in the various countries abroad, a small increase took place during 1924. At the beginning of the year the tonnage under construction amounted to 1,049,155 tons, and at the end of December the total was 1,173,465 tons, an increase of 124,310 tons. The countries which showed the largest increases were:—France, 86,445 tons; Germany and Dantzig, 42,420 tons; and Italy, 35,127 tons; while considerable decreases have taken place in the United States, 33,411 tons, and Japan, 24,217 tons. The returns for the fourth quarter showed that at the end of 1924 the countries abroad having the largest amount of tonnage under construction were:—Germany, 355,250 tons, excluding Danzig with 23,794 tons; France, 197,170 tons; Italy, 154,790 tons; Holland, 124,766 tons; and Denmark, 84,828 tons. The total tonnage under construction abroad at the end of 1924 includes about 67,000 tons on which work is suspended. This figure is practically the same as it was at the end of 1923, and represents a very small percentage of the total tonnage being built. The tonnage commenced was considerably larger than the similar figure for 1923, and steadily increased throughout the year. It would therefore appear that an appreciable improvement is now taking place in the conditions prevailing in many of the shipbuilding yards abroad.

SUMMARY OF WORLD'S OUTPUT.

The total World's output during 1924 reached 2,247,751 tons. This figure represents an increase of 604,570 tons, as compared with 1923, but it shows a decrease of 1,085,131 tons, as compared with 1913, during which year the pre-war world's record output was reached. The output in Great Britain and Ireland represented 64.1 per cent. of the world's output during 1924; a much higher percentage than was the case in recent years, and a percentage which is the highest reached since 1911.

Some interesting facts may be gathered from the summary as regards the special types of vessels and machinery included in the output of the year under review. The total launches included 32 vessels of about 284,700 tons which will be fitted with steam turbines. The average tonnage of these vessels reaches 8895 tons. The tonnage of new vessels which are being fitted with internal combustion engines is steadily increasing. During 1924 about 501,798 tons were launched, as compared with 226,040 tons in 1923. The present total represents about 29½ per cent. of the world's output of steam tonnage, as compared with about 16½ per cent. in 1923; and it may be stated that the tonnage of motor ships being built in the world at the beginning of 1925 represents over 60 per cent. of the steam tonnage under construction, as compared with 35 per cent. twelve months ago, thus showing the remarkable development which is taking place in the adoption of this system of propulsion.

As compared with 1919, the shipbuilding output of the world for 1924 was 4,896,798 tons less. It may be stated that during the last three quinquennial periods the total addition to the world's merchant navies by new construction amounted to over 48¾ million tons, viz., 1910–1914, 13,695,397 tons; 1915–1919, 18,419,497 tons; 1920–1924, 16,561,361 tons. In this connection it will be of interest to compare the total of the world merchant fleets in 1914 with the latest available figures. Disregarding sailing vessels and wood steamers, in view of their comparatively small importance in international trade, the gross tonnage of sea-going steel and iron steamers and motor ships amounted in June, 1914, to 42,514,000 tons, while at June, 1924, the figures reached 57,530,000 tons—an increase of over 15 million tons.

A remarkable change has taken place in the total tonnage of some types of vessels included in the above figures.

For instance, the tankers, which in 1914 totalled 1,479,000 tons, now amount to 5,243,000 tons; and motor ships, which in 1914 only reached 234,000 tons, now amount to close upon 2,000,000 tons. A great change has also taken place in the relative use of coal and oil fuel for boilers. In 1914 the tonnage of the steamers fitted for oil fuel was 1,310,000 tons, whilst the 1924 figures show no less than 17,154,000 tons.

Of course, the amount of shipping laid up has a most important bearing on the question of finding profitable employment for the enormous tonnage now in existence. The latest figures which have been published for all countries relate to July, 1924, when well over 6,000,000 tons gross were laid up, over two-thirds of this total being United States vessels. The United Kingdom figures, which then reached 700,000 tons, have, however, since been reduced to about 570,000 tons.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Market Position Unchanged.

LITTLE progress is being made in the Midland iron and steel industry towards that revival in business which was confidently anticipated when the year 1925 came in. There has been a solid expansion in the volume of business since the depression was at its worst, but little new life has been infused into the market so far this year, and the first quarterly meeting was frankly disappointing. Manufacturers here continue hopeful, and the market tone keeps up well, but business lags. Consumers of iron and steel alike hesitate to commit themselves to forward buying. They cannot see far enough ahead. Specifications are beginning to come in more encouragingly in one or two directions, but, nevertheless, the business circulating at the moment is far below productive capacity. Many mills are idle; others are working intermittently. Some good orders for rolling stock have recently come into the district and fairly substantial quantities of best iron and steel should be required for their execution. The position on the whole shows little change on the week.

Steel Improvement Maintained.

Though the slight improvement in the steel trade recorded last week is maintained, a very considerable advance will be required before anything in the nature of a real revival can be registered. There is still a very large amount of unemployed capacity, and really big business is scarce. Rail and shipbuilding orders are far from numerous. The most powerful mills are mainly dependent on plates for large construction, such as gasholders, pipe lines, &c., for which good orders have been given out, one of these being secured by a Birmingham firm of engineers using Welsh steel. Steelmasters on 'Change in Birmingham to-day—Thursday—reported that more structural work is coming to hand, and demands from the sheet trade are growing. Steel values continue irregular, cutting being prevalent in many branches, owing to the keen inquiry for specifications. There is no marked change, however, on last week's quotations. Angles and joists make £9 to £9 5s.; tees, £10 to £10 5s.; small steel bars, £9 upwards; ship, bridge and tank plates, £9 15s.; boiler plates, £13 10s. delivered. Staffordshire hoops sell at £11 10s. at works. There is only a limited business being done in mild steel billets, but the price has risen to £7 2s. 6d. This is accounted for by the withdrawal of the £7 quotation given for the past few weeks by some of the Welsh billet makers, who were badly in want of business on account of the falling off of orders from the tin-plate trade. Most makers continue to ask £7 5s. upwards, but there is little business to be got, despite the fact that the prices of imported half-products have stiffened. Some of the Belgian quotations for billets were appreciably higher this week. Variability is the prevailing note of this trade however. Figures ranging from £6 7s. 6d. to £6 15s. were mentioned, and the former price was not the actual minimum. Makers of high carbon billets have excellent order books.

Staffordshire Iron Depressed.

The Staffordshire finished iron trade continues rather depressed. Material is being called for only on a hand-to-mouth scale, and there remains a good deal of unemployed plant. Marked bars continue the most active section, being in fair demand at £15. Makers are getting orders from week to week, sufficient to keep them employed. For medium qualities the competition is difficult, with steel at much lower prices. It is remarkable that whereas steel is much lower in price than a year ago, iron bars are dearer in spite of a fall of at least 15s. in the price of pig iron. So far, efforts to cheapen production have failed, and wages have advanced substantially since a year ago. Crown quality iron continues to be quoted at £12 15s., and nut and bolt and fencing quality iron £11 15s. Competition from the Continent in nut and bolt iron is very keen, and what few orders come on to the market go for the most part to Belgian firms, at prices ranging from £7 12s. 6d. to £7 15s. Wrought iron gas tube strip is in fair demand, and commands from £13 to £13 5s.

Sheet Values.

Galvanised sheets have been in improved request again this week. It is chiefly the thinner gauges that are being called for to meet the requirements of Japan, China, and some other overseas markets. A fair business, however, continues to be done in 24 gauge corrugated sheets, quotations for which are round about £17 5s. per ton f.o.b.

Raw Iron Quietude.

The Midland pig iron market remains quiet, consumers still being unprepared to give out large contracts or to buy forward. Producers have to be content with the small orders offering, but they are not pessimistic, and are holding on to late prices in the hope of an early impulse. In the same way, coke suppliers are very firm in their demands. Some of the furnacemen are well sold over the next month or two. Others, with affiliations in the pipe trade, are finding use for most of their output. Accordingly, the stability of the position is not seriously shaken by the prevailing market quietude. There will have to be much greater pressure for supplies, however, if additional plant is to be brought into service in South Staffordshire. Northampton foundry pig iron is rather easy at £3 17s. 6d., and Derbyshire at £4 2s. 6d. Forge iron can be bought at £3 11s. from Northampton, and £3 17s. from Derbyshire. At present the production appears to be fully equal to the demand.

Foreign Competition.

An unfortunate feature of last year's trade returns, the meaning of which is well understood in this district, was the increase of over 8½ millions in the imports of iron and steel and manufactures thereof. Continental competitors by dint of their lower production costs were able to drive our ironmasters out of the field as regards a considerable range of material, and until there is a fairer acceptance of the burdens which the war has laid upon the nations, we shall continue to struggle at a disadvantage. In 1913 we were importing iron and steel at the rate of 186,000 tons a month. Last year the average was over 202,000 tons. The increase of 16,000 tons becomes a very much more serious matter than it looks at first sight, when we contrast the busy industrial conditions of 1913 with the depression which hangs over the iron trade to-day. The strength of this foreign competition is indicated by the importation last year of 704,790 tons of steel billets, as compared with 418,271 tons for 1923. Steel bars, rods, &c., totalled 317,901 tons, compared with 143,563 tons. All other imports showed substantial increases. Of railway rails, for example, we imported 20,849 tons, against 9361 tons in 1923. For this formidable competition the low exchanges are mainly responsible.

Production Figures.

The December figures of pig iron production show that the recent increase is maintained, though the output of pig iron is still 40,000 tons below that of a year ago. The production included 198,500 tons of hematite, 163,400 tons of basic, 158,200 tons of foundry, and 33,500 tons of forge pig iron. The steel ingot production during the same month was only 551,000 tons against 674,300 tons. While the holidays were partly responsible for this, the total is 100,000 tons below that of a year ago. The total production of pig iron for 1924 was 7,318,900 tons, and of steel 8,221,100 tons, compared with 7,440,500 tons and 8,481,800 tons respectively in 1923.

Large Orders for Birmingham Firms.

Considerable satisfaction is expressed at the amount of business which has been allotted to Birmingham rolling stock firms by the London, Midland and Scottish Railway Company in connection with its £14,000,000 scheme of new construction of rolling stock. Orders have been placed by the company for 293 third-class vestibule coaches, 25 of which will be fitted with brake compartments. A considerable number of these will be made by the Birmingham Railway Carriage and Wagon Company and the Metropolitan Carriage, Wagon and Finance Company, Birmingham, and the Midland Railway Carriage and Wagon Company. These vestibule coaches, it is of interest to note, are to be of a new type, a feature of the specification being the entire use of steel for the bodies and frames, which are to be built in one unit. A large proportion of the 5100 wagons of various types for the company are also being made by these Birmingham firms.

Big Contract for Steel Pipes.

It is understood in the Midlands that Thomas Piggott and Co., Limited, of Birmingham, have been successful in obtaining the order for the supply of 20 miles of steel pipes for the Taff Fechan Joint Water Board, in connection with the reservoir being constructed at Pontsticill, in Breconshire, for the extension of the water service to Merthyr and other contributory townships. Messrs. Piggott, it is understood, are to supply the pipes at a cost of over £100,000, while the steel plates for the pipes are to be made at Cardiff by Guest, Keen and Nettlefolds.

Derbyshire Miners' Dispute.

The handing in of strike notices by men at the soft coal pits in Derbyshire to enforce the restoration of 7½ per cent. reduction in wages mutually agreed upon in 1922 has been completed, but until the official figures are made known—they were not to hand at the time of writing—it is not possible to say which way it has gone. On the one hand, it is stated that the threatened strike is not likely to materialise, as not more than 40 per cent. of the men affected signed the notices, and, on the other, the view is expressed that the ballot was "fairly solidly supported." It is acknowledged there is no enthusiasm for the threatened strike, and the fact—if such it proves to be—that so many men have failed to give notice to terminate their services will lead to complications when it is due to begin. Twenty thousand men are concerned in the dispute, either willingly or otherwise.

Unemployment.

The considerable displacement of labour which the turn of the year always involves resulted in the employment figures for the Midlands area mounting to a very high level, and it is something to find that the latest returns show a fall of 8279. There are, however, still 105,682 men, 3757 boys, 42,966 women and 4901 girls—a total of 157,306 persons—on the unemployment registers in this area. The Birmingham area is responsible for 34,142; Bilston, 3347; Coventry, 1772; Cradley Heath, 4675; Derby, 2169; Dudley, 4743; Hanley, 4156; Leamington and Warwick, 692; Leicester, 4532; Longton, 4590; Northampton, 1633; Nottingham, 9247; Oldbury, 1924; Peterborough, 657; Smethwick, 4040; Stourbridge and Brierley Hill, 4361; Tipton, 2338; Walsall, 6312; West Bromwich, 3505; Wolverhampton, 6058; Worcester, 2446; and Redditch, 1373.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE disappointment felt in the Manchester markets this week at the failure of the expected revival in trade is quite keen, and shows how confident many people were that British trade was recovering from its difficulties. The many hindrances in the way of a return to normal conditions have been largely ignored, or it would have been impossible to avoid the conclusion that a revival of trade in this country must necessarily be a slow process. The general conditions of the trade of the world are changing, and all round the various smaller countries are trying to do without British goods and to manufacture for themselves. This tendency has invaded our Indian dependency, and must, if further developed, have an enormous influence upon British export business. What is wanted, if export trade is to be saved, is a determined effort on all sides, including the side of labour, to reduce costs; and one sees little evidence of that effort yet.

Metals.

The markets for the non-ferrous metals have disappointed the "bull" speculators recently, and there has been a considerable lessening of confidence here, which has restricted buying and given a very dull appearance to business for the time. Nevertheless, it is doubtful whether this is more than a temporary setback in a movement which will bring metal prices, or, at any rate, copper prices, to a higher general level. If we look back it is found that three or four months ago standard copper was fluctuationg between £62 and £63, whereas it is now fluctuating between £66 and £67, and hence a very substantial advance has already been accomplished, almost imperceptibly. It seems reasonable to believe that this upward movement, slow as it is, will continue so long as the world is progressing in its efforts to get away from the paralysing results of the Great War. There is probably no necessity for the consumer of copper to buy in a hurry, but, on the other hand, to carry reasonable stocks of the metal is now fairly safe; for the chances are that they will not be worth less when they come to be used. Export business in copper has been rather quiet of late; but the holiday season will probably account for this. European imports of copper last year were substantially larger than in 1923, and there is no reason to suppose that this quiet growth in European consumption will not continue in 1925. Evidently the American copper experts are reckoning upon this, and, as a matter of fact, the American view of the prospects of the market is more optimistic than the view taken here. The market for tin has been erratic again, but the belief here in higher prices eventually seems to persist against all fluctuations. The appearance of larger supplies of metal is, of course, disconcerting to the bulls, but it is claimed that this is merely a temporary phase, and that when the American spring demand comes on, the market will present a different appearance. The strength of tin, of course, lies in the fact that the extra reserve supplies have now come to an end. Lead has suffered a slight reverse, and people who foretold £50 for English lead are not now so confident; but one cannot see that the underlying conditions have changed. Spelter re-acted slightly in sympathy with lead; but, of course, the price of spelter is not particularly extravagant.

Pig Iron.

The demand in Manchester for foundry iron this week seems quieter, and one hears mostly of small transactions at the conventional prices. Whether if any very large business were offering some makers might be inclined to give way a little is a debatable question, but so far sellers of Derbyshire No. 3 iron are steady at 90s. per ton delivered in this district; and there is not much foundry iron of other brands offering. It might be possible to buy Northamptonshire iron here at 88s. 6d., but one cannot find that there is any demand for it. The ironfounders of Lancashire are still suffering from too keen a competition for orders, and a wide demand for castings is needed. This may come when the cotton trade begins to spend money on machinery, but it can scarcely come before then. The price of No. 3 Scotch iron in Manchester remains at 107s. 6d. per ton, and, of course, the difference of 17s. 6d. between Scotch and Derbyshire hinders the sale of the former; but one cannot see how this difference is to be reduced while the railways insist upon getting their "pound of flesh" in the way of extravagant carriage rates. East Coast hematite iron is moderately cheap in comparison at 100s., or a little less delivered here.

Finished Material.

One cannot yet find any improvement in the demand for manufactured iron and steel. As for bar iron, of course the price stands in the way of any serious increase in the demand; but this can scarcely be said to apply in the steel trade. Compared with iron prices steel is moderate, although, of course, the continental steel is much cheaper. Apparently the tendency in sections is, if anything, downward, whereas it was confidently expected that by this time a revival would have set in. The nominal quotation for joists and angles is still £9, but one frequently hears now of £8 15s., and it looks as if very soon that figure would be the nominal price. Sellers of plates and bars quote £9 15s., and possibly this price has not been cut for plates, but for flat bar steel it is said to be shaded sometimes.

Scrap.

The market for steel scrap here seems to have had a setback, and that although there has been no fall

reported in the Sheffield market. Probably the truth is that Lancashire dealers have been anticipating rather too much in the steel scrap trade, and have been putting up the price here against one another. At one time 72s. 6d. on trucks in Lancashire was reported as having been paid. Now apparently the highest price being offered by the dealers is 67s. 6d. on trucks for good heavy melting scrap. Heavy wrought iron scrap remains quiet, and as there is not much of that probably 90s. per ton can still be obtained. Cast scrap is in moderate demand only at 85s. to 90s. per ton delivered here.

South African Engineers in Manchester.

A party, comprising thirty-two engineering students from the University of Capetown, and three members of the University staff, has been paying a round of visits to works of engineering interest in this district during the week. The party arrived in Manchester last Sunday evening, and on Monday inspected the Manchester Ship Canal, the College of Technology and the University. On Tuesday the programme included a trip to Preston, where the works of the English Electrical Company were inspected. On Wednesday the works of Metropolitan Vickers Electrical Company and Mather and Platt were thrown open to the students, and on Thursday Hans Renold and Mirrlees, Bickerton and Day, Limited, entertained them. To-day—Friday—the party goes to Wigan to inspect various works, and on Saturday the students will visit a cotton mill. During their stay in Manchester the visitors are being accommodated at the University Hostels and "Toc H." From Manchester the students will go on to Newcastle-on-Tyne, and thence to Sheffield, returning to South Africa on February 20th.

An Interesting Old Coin.

The halfpenny token dated 1792, which was alluded to in a paragraph under the heading "Miscellanea" in last week's issue of THE ENGINEER, was apparently made with at least one other design on the reverse side. I have been shown a coin evidently from the same source, which resembles that referred to as regards the obverse identically, but on the reverse is a sailing ship, and the date 1792. This coin has been in the possession of the present owner for about fifty years.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade is about the same. There is no improvement, but, on the other hand, there is no falling back, and judging the position generally the prospects are good, although the improvement will be slow. The demand is not very keen, and makers have not increased their prices, which will be the first sign of improved business. The present price of pig iron does not leave much or any margin for profit. The home demand is steady. The business with the Continent is quiet, but American trade is better, although one cannot say how long it will remain so. The iron made at Barrow is mostly going into the steel works for the rail mills. The inquiry for special qualities of iron is slightly better, due no doubt to the better trade in the engineering industry.

Iron Ore.

The iron ore trade remains about the same, with a little more going out of the district than was the case a few months ago. The mines are not at full output, nor are they likely to be until there are more furnaces in blast. The business done in Spanish and North African ores is steady. One or two cargoes destined for this district have been unfortunate. Five thousand tons were lost the other week when the Western Valleys sank in Morecambe Bay, and on Tuesday morning the Arnotegi-Mendi, a Spanish steamer, carrying 6000 tons of ore, went ashore at the entrance of the Barrow channel. Efforts will be made to get her off.

Steel.

The steel trade remains dull, with few orders obtainable and plenty of competition for them. The Workington rail mills are not regularly employed, but the Barrow rail mills are still working, although fresh orders are necessary to keep them going after this month. The hoop and small section mills are better situated. Foundries are fairly well off for work.

Shipbuilding.

Vickers will launch from their yard on Saturday the Warren Liner Newfoundland, and in about a month's time the Cunard liner Corinthia will come off the stocks. The Corinthia was originally to have been named the Servia. The construction was held up for a considerable time owing to the slump in the shipping trade. This vessel has been altered in internal design, and it is believed that she is intended for running the various trips to the Mediterranean, &c., which have now become so great a feature with the Cunard Company and which are so largely patronised by Americans.

SHEFFIELD.

(From our own Correspondent.)

Reaction in Commercial Steel.

THE state of the ordinary steel trade continues very unsatisfactory, and the hopes with which the New Year was welcomed are fading away, although they have not disappeared yet. There has been a reaction during the past few weeks, and the position is worse than it was in December. Prices paid then by purchasers who made forward contracts were higher than those now ruling. Pig iron is half-a-crown a ton cheaper, and there have also been falls in the prices of scrap and crude steel. In view of this tendency, buyers are naturally more cautious than ever, and only a very limited amount of business is passing at the moment. The figures of foreign trade for the past year show how serious was the handicap which British industry had to meet in the way of continental competition, and remove all cause for wonder at the poor results shown by our home industry. Record figures were reached by imports of basic pig iron, basic billets, rolled steel, and wire rods. To take only one figure as an illustration, we received during the year 704,790 tons of billets, as compared with 418,790 tons in the previous year. There are signs that the fierceness of this competition is diminishing, as costs of production on the Continent are rising. Mr. C. K. Everitt, a director of Edgar Allen and Co., Limited, in a speech which he made on Monday, on retiring from the presidency of the Sheffield Society of Engineers and Metallurgists, dwelt on both sides of the question. Speaking with reference to the outlook, he pointed out that French exports of iron and steel had fallen by nearly 50 per cent. within a period of less than six months. That fact served, he said, to strengthen the belief, now generally held, that the worst of the depression was past, and that British finance and British industry would ultimately reap the benefit of the heavy sacrifices which had been borne so uncomplainingly.

A Scrap Alliance.

A good deal of importance is attached to the announcement which was made last week of the formation of a company called the Steel Supply Company, Limited, with a nominal capital of £22,000, two directors of which have been nominated by the United Steel Companies, Limited, and two by George Cohen Sons and Co., Limited. Messrs. Cohen are among the leading merchants of iron and steel and scrap materials in the country, and it is assumed that the alliance will enable the Sheffield concern to obtain its scrap materials at favourable rates. It is suggested that United Steels will make themselves quite independent of local merchants, who will thus have more materials to offer to other users of iron and steel scrap.

The Manufactured Side.

The trades in finished steel products are doing considerably better than those which turn out raw and semi-manufactured materials. There is a steady increase of work in several important departments, notably tools and files, and many of the firms engaged in these trades are now running not far short of full capacity. At the same time, instances of slackness are not wanting, and there are cases in which trade has fallen off, saws being one of them. A large amount of special steel is still being produced for the motor trade. A remarkable tribute to Sheffield's excellence in this respect is afforded by the performance of the first car to make a double crossing of the Australian Continent. The exploit was celebrated by a dinner given at the Hotel Cecil this week by A. Harper, Sons and Bean. The car used was a standard Bean "fourteen" five-seater, which was built of Sheffield steel, manufactured at the works of Hadfields Limited. It made the journey from Sydney to Port Darwin and back, a distance of 6200 miles of uncharted country, and is still, although battered and weather-beaten, sound in every part. Mr. J. H. Bean, in the course of the evening, remarked that he was optimistic as to the future outlook of trade. They were doing more business now than a year ago, and the high quality of goods manufactured made for prosperity which was reflected in other trades.

The All-steel Coach.

The £14,000,000 programme of new construction, announced by the London, Midland and Scottish Railway Company, has a very interesting feature in the fact that steel is to be used for the bodies and frames of coaches of a new heavy type. Where it may be necessary to introduce timber for fittings and linings special wood of a practically non-inflammable kind will be used. Sheffield firms are to share substantially in the orders for the 235 third-class vestibule coaches—thirty-five of them fitted with brake compartments—which have been placed. Cammell Laird and Co., Limited, participate in the contracts, both at their Nottingham works and at the Leeds Forge; and Vickers Limited have secured a portion, through their subsidiary, the Metropolitan Carriage, Wagon, and Finance Company. The Birmingham Carriage and Wagon Company has also received some of the orders. Full particulars have now been published as to the allocation of the orders for the 5100 wagons of various types which the L.M. and S. Company is to build. A number of local firms are among those which will benefit from this large amount of building activity.

Trailer Building in Sheffield.

A new addition to the activities of Sheffield will be the production of the "H.B." trailer, the manufacturing and selling rights of which, in the United Kingdom, have been acquired by Sheffield Steel Products, Limited, of Templeborough. This patented self-loading and tipping trailer is fully automatic in action and embodies a number of ingenious and valuable devices making for convenience and economy in use. It is being built at the Templeborough works in three sizes, to carry respectively loads of 4, 5, and 6 tons, and is suitable for use with any type of motor lorry or tractor. Among the advantages claimed for it are the fact that it discharges or picks up a load at any angle or direction; that it can be manœuvred, backed or turned into any position while tipped and without uncoupling and for any distance; that it can be disconnected or connected without the necessity of the attendant risking accident by standing between the vehicles; that it is entirely controlled from the driver's seat, and that it can be converted into a bolster wagon for dealing with long lengths.

New Housing Materials.

The great attention which is now being paid to the housing question in all parts of the country has stimulated interest in new building materials, and this district is taking a prominent part in the innovations. I have already referred to the proposal to build cast iron houses at Rotherham. Another scheme of the same kind, with which the well-known coal and iron firm of Newton, Chambers and Co., Limited, is associated, is now to be put into operation at Mortomley, a few miles from Sheffield. The Wortley Rural Council has approved plans for two of these houses, each of which will have six rooms of ordinary size, and a bathroom. They will have an inside lining of fireproof material. It is estimated from the designs that they will be ready for occupation in four to six weeks from the time of starting. Hull and Leeds are to build steel houses on the Weir principle, and the Housing Committee of Hull Corporation has also before it the plans of houses of reinforced concrete, built by Mr. R. G. Tarran, of Hull. The latter are estimated to cost from £450 to £475 each, and can be completed in twenty-eight days. Each contains a living room, large scullery, three bedrooms and a bathroom. The concrete slabs are cast in moulds on the building site, the size of each standard slab being 6ft. by 2ft. 9in. by 3in. thick. They are cast by unskilled labour under skilled or semi-skilled supervision. A wooden framework was proposed, but in view of the Ministry of Health's objection to the use of wood in a concrete house, the designer is prepared to substitute steel, properly protected against corrosion. It is understood that, with this alteration, the Hull Committee would have no objection to accepting the plans.

A Centrally Heated Estate.

The Brightside Foundry and Engineering Company, Limited, of Sheffield, has secured the contract for a central heating installation on interesting lines, which is full of promise from the points of view of fuel economy and smoke abatement. The plant is intended for the supply of hot water to new miners' houses which the Denaby and Cadeby Colliery Company is having built at Conisborough. There are to be 800 houses on the estate, of which 400 are now being built, and the central heating plant is designed to supply the full complement. Two boilers, 30ft. by 7ft., are to be installed, with water tower, circulating pumps, and about 12 miles of piping. The main circulating pipes are to be carried overhead on piles across the yards and gardens, and the supply pipes will be run through the houses under the ground floor ceilings. The economy of fuel consumption is expected to be considerable, as during the summer months there will be heat losses from the central station chimney only instead of from 800 house chimneys. The gain in the matter of smoke prevention is also important; in fact, it is suggested that, with a good draught and proper stoking, there should be practically no smoke from the central chimney. The approximate cost of the whole installation will be £14,000.

Important Yorkshire Bridge.

A definite step towards the construction of the proposed new bridge at Boothferry was taken by the West Riding County Council last week, when it decided to promote a Bill for powers to proceed with the construction. Boothferry is on the Ouse, two miles north-west of Goole. There is no existing bridge over the Ouse, constructed to comply with present-day requirements, between Spurn Point and York, and the necessity of a new bridge has been keenly felt for a long time. The present scheme was on foot before the war and was revived by the Ministry of Transport in 1923, when it called a conference of the local authorities concerned, who unanimously decided to proceed with the erection of the bridge. It will form an essential part of a new trunk road from Doncaster to Hull which the Ministry has in contemplation, and will also provide a connecting link between the general systems of roads in the East and West Ridings. The cost was originally estimated at £100,000, and it was agreed that this sum should be borne in the following proportions:—Ministry of Transport, £50,000; West Riding County Council, £30,000; Hull Corporation, £10,000; East Riding County Council, £5000; and Goole Urban District Council, £5000. The lowest tender received was £100,612, and since then the total estimate has been increased to £112,500, which includes cost of land, easements, &c. Subject to any special contribution which may be made by the Ministry, the additional cost will be met in the same proportions as the original amount. When the bridge is completed and in operation half the cost of its maintenance and working will be borne by the Ministry and the other half will be divided equally between the two County Councils.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

MOVEMENT towards a more normal state of affairs in the Cleveland pig iron trade proceeds very slowly. At the moment the trade presents some curious contrasts. The market is admittedly weak, and yet there has not been a time in the past year or so when ironmasters' stocks were so low, or when they had such big contracts on their books. These latter, however, are for delivery over long periods, and apparently current consumption is scarcely sufficient to cover current output, hence the slight sag in prices which has taken place since the New Year. The real weak spot is the export trade. The volume of overseas trade, whilst it shows some expansion, is still very disappointing, and is very largely confined to the arrangement of contracts to meet early needs. There is still considerable foreign competition, but from certain quarters it is less keen than it has been. Cleveland pig iron has, however, still to contend with low prices at Antwerp for foreign iron; whilst the further decline in the lira has practically closed Italian markets, both for Cleveland and hematite irons. Conditions in America are more satisfactory, and encourage the hope of further buying here for Transatlantic shipment. Happily, the home consumption of pig iron is substantial. The foundries are still busy, and their requirements tend to expand. At the same time, the weaker prices have caused a certain hesitancy on the part of buyers, who incline to wait until stability has been reached. No. 3 G.M.B. Cleveland pig iron is now quoted at 80s. per ton, No. 1 at 85s., No. 4 foundry 79s., and No. 4 forge 78s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade shows little change. Makers are very keen for orders, and there has been an attempt to firm up the price, some producers asking 87s. 6d. per ton for mixed numbers. The ruling price, however, is no more than 87s. per ton, with No. 1 at 6d. premium.

Ironmaking Materials.

Trade in foreign ore is stagnant. Sellers still base market rates on best Rubio ore at 22s. 6d. per ton c.i.f. Tees, but would doubtless favourably consider offers at less, and it is difficult to ascertain on what terms contracts might be arranged. The coke market is weaker, and although some of the stronger firms adhere to 25s. per ton for good medium furnace qualities delivered at the works as their price, supplies can be bought at 24s. 6d. per ton.

Manufactured Iron and Steel.

The manufactured iron and steel trade presents few new features. Demand for semi-finished material is only moderate, but satisfaction is derivable from the reported diminution of parcels offered from the Continent. Finished steel is in a little better request, chiefly on home account. Prices are well maintained.

The Coal Trade.

There is no new development in the Northern coal trade, and the market remains very quiet. Operators confine themselves to securing supplies solely for hand-to-mouth deliveries, and thus for the next week or two the position is steady from the point of view of the collieries, but they can only count on business for a few days ahead. As, however, they have been carrying on under these circumstances for some weeks, they still take a favourable view of the outlook, and, despite contractors and speculators both holding off the market, they ask steady values for every description of coal, either for prompt or for delivery over the next few weeks. The position for the remainder of January is fairly satisfactory to most producers, and in the majority of cases they are well stemmed, and while eager to secure forward trade, are declining to discount values. The almost total lack of forward trade, however, is causing considerable surprise among merchants. Replies from the Continent to all offers state that stocks on hand are ample for current requirements, and that continental speculators are offering all grades of Northumberland and Durham coal at discounted figures compared with direct. This is no doubt due to the keen German competition. For instance, offers of best steam coal were wired to a large Norwegian works at 18s. 6d. per ton f.o.b., but the order was taken up by Norwegian merchants at 18s. 2d. per ton f.o.b. Similar reports come from other centres. The coke trade is quiet. There is a good general inquiry for foundry cokes from Germany and Belgium, but merchants find German prices too low to compete against, and generally the bulk of these orders passes into German hands.

German Coal Competition.

As a definite illustration of the competition of German coals against those from the North-Eastern district a perusal of definite tonnage requirements for conveyance of coals from Rotterdam is an eye-opener. A circular just to hand asks for definite tonnage offers for the conveyance of coals from that port for large cargoes to certain ports named. All these ports until just recently had never failed to take anything but British coals, mainly Northumberland or Durhams. Tonnage is definitely required for 6000 tons of coal to Herrenwick, medium cargoes for Landscrona, Malmo, Goteborg, Kalmar, Halmstadt, Stockholm, Oxelsund, Seville, various Mediterranean coaling stations, Italian ports, Constantinople, and River Plate. These freights are from Rotterdam, but numerous freights are quoted also for shipment from various German ports. The circular provides a slight idea of the amount of tonnage required from continental ports for destinations to which for some years the trade has been almost entirely in British hands.

SCOTLAND.

(From our own Correspondent.)

Continued Depression.

THE New Year is now three weeks old, and there is yet no sign of a broadening out of trade generally, or in any particular branch of the steel, iron or coal industries in Scotland. As a matter of fact, conditions are practically as slow as in the quietest periods last year. Foreign competition is still very keen, and affects all three industries to a considerable degree, and the outlook is only brightened a shade by the slightly upward tendency of prices quoted from abroad. Provided this movement continues, the outlook would improve likewise, but just at present business is about as slow as it could possibly be, short of a cessation altogether. There are instances here and there of comparative activity, but in the majority of cases employment is most irregular or confined to small numbers, as a considerable proportion of plants are still out of commission, and are likely to remain so until some definite improvement takes place in trade.

Pig Iron.

The pig iron market is barely steady. Demands for hematite and foundry qualities are most disappointing. Deliveries of foundry are chiefly confined to quantities purchased about the end of last month, and there is a dearth of fresh orders. Likewise, the steel works' requests for hematite is at a minimum. Prices are nominally unchanged, but for a good order terms could be arranged.

Steel and Iron.

A lack of specifications still retards the putting into operation of additional plant, the output, restricted as it is, being easily sufficient for all demands. The only exception is found in the case of steel sheets. Orders for shipbuilding materials are specially disappointing, but the difference in price between home and foreign products is still too great to be ignored. Sectional steel also has few demands. Steel sheets, on the other hand, and especially galvanised descriptions, are very busy and firm in price. The inquiry for light sheets is heavy for both flat and corrugated varieties, while sheets of the heavier gauges are improving. The bulk of the business being done is on export account, but there are signs of an opening up of the home trade. Bar iron and re-rolled steel materials experience a very lean time, and it is only with difficulty that a minimum amount of employment is maintained.

Coal.

At the close of last year it was anticipated that business in the Scottish coal trade would expand considerably within a week or two. Up to the present there is no indication of any such happening, conditions being fully as slow as at any period last year. Apart from Lanarkshire splints, all descriptions of fuel, and especially washed materials, are very difficult to dispose of, even when prices which are considered unremunerative are quoted. The drop in foreign demands is most keenly felt in Fifeshire and the Lothians, where in normal times export is the chief source of disposal. Generally speaking, prompt orders are extremely scarce, and the depression is really so acute that the question of closing pits is an ever present one. Idle time is far too prevalent, and if the present weakness in the market is persistent, it is almost certain that many pits will be closed until busier times are assured. Meanwhile splints are fully booked up, chiefly for the Italian market, and are the only description of fuel to be so placed. Washed materials are particularly weak, and are being pressed for sale. The amount of tonnage at the ports is limited at present. Aggregate shipments amounted to 224,006 tons, against 176,631 tons in the preceding week, and 274,838 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE conditions in the steam coal trade continue to be comparatively quiet, and prices, generally speaking, are much on the lines of those prevailing a week ago, except that weak spots for prompt loading are not quite so numerous. This is due to the fact that tonnage arrivals at South Wales ports over last week-end were fairly good, so that the week was started well, inasmuch as there were no vacant loading berths at the docks at Cardiff, Penarth, Barry and Newport. The majority of collieries were in the circumstances comfortably placed. The market does not, however, as a whole display any real life, a fact which is due to the paucity of the foreign demand. This demand has not been at all active since the opening of the New Year, but of late orders have been held up for the reason that the foreign exchanges have induced buyers abroad to hold their hands for the time being. The Norte Railway of Spain is in the market for about 30,000 tons of Admiralty large coals for delivery at various Spanish ports by the middle of March, but apart from this, the business principally being negotiated is in respect of single cargoes, though a few inquiries are circulating for a monthly cargo for delivery over the remainder of this year.

South Wales Trade.

. An interesting statement has been issued by the Great Western Railway Company respecting the trade at the South Wales docks for the year 1924, this, of course, being the first return made by this undertaking since it came into control of the docks. The docks comprise those at Cardiff, Barry, Penarth, Newport, Swansea and Port Talbot. The aggregate tonnage dealt with at these docks amounted to 40,392,458 tons, of which exports comprised 34,392,222 tons and imports 6,000,236 tons. As regards the individual ports, Cardiff takes pride of place with an aggregate of 10,409,218 tons, Barry docks being second with a total of 9,603,187 tons, Swansea third with 7,387,901 tons, Newport fourth with 6,957,701 tons, Penarth fifth with 3,099,872 tons, and Port Talbot sixth with 2,934,579 tons. Coal and coke naturally form the chief exports, and it is noticeable that under this heading the figures for Cardiff are surpassed by the Barry docks. Cardiff's quantity of 7,684,400 tons compares with 9,052,443 tons at Barry docks, but the figures for Cardiff exceed those of the other ports. Other principal exports and imports comprise patent fuel, timber, iron and steel, grain and flour, cement and general merchandise. At Swansea oil imports stand prominently in the returns, the total being 1,068,490 tons. Penarth also imported 12,445 tons, and Barry 785 tons, but Cardiff, Port Talbot and Newport imported none. Swansea also exported 847,874 tons of oil, and heads the list in respect of tin-plates, with a total of 621,524 tons, Newport coming next with 44,624 tons.

The Tin-plate Trade.

Although there are still several thousand men idle in the tin-plate industry, the position is slightly improved, and several works are commencing to operate more regularly. The outlook is regarded more optimistically, though it is alleged that the existing depression is partly attributable to orders having been held up in consequence of the dispute between the makers themselves on the question of the marketing of tin-plates. As against this, the interesting report is current that developments are afoot which are calculated to revolutionise working in tin-plate mills in South Wales, and will bring about an enormously increased output, which will considerably assist manufacturers to meet all competition. A new tin-plate mill embracing a number of labour-saving appliances is to be laid down as an experiment, and one estimate is that the effect of the improvements will be to bring about a five-fold increase of output. Such a result would, of course, have very far-reaching influences. Doubtless, the introduction of new methods will be a fruitful source of discussion between employers and workmen, but hopes are entertained that the latter will not make matters difficult. It is understood that the invention has been patented, and is the property of a gentleman who has been connected with the industry for many years. The present system of tin-plate rolling is practically as old as the industry itself.

Steelworkers' Wages.

The quarterly ascertainment of the price of tin-plate bars, which governs the sliding scale arrangement in the tin-plate bar and tin-plate industries, shows that for the period ending December 31st, the average price of bars was £8 5s. 2½d. per ton, which is equivalent to 32½ per cent. under the sliding scale and 1½ per cent. below the present scale. This new ascertainment governs wages to be paid from February 1st to May 2nd, but the men have hitherto received *ex gratia* payments, conceded owing to the low state of the sliding scale. The continuance of these concessions for a further period will be considered by the joint boards in due course.

Docks Working Hours.

As the result of a conference between representatives of coalowners, shipowners, coal exporters, the dock and railway company and representatives of the trimmers and tippers of South Wales, a committee has been appointed to investigate the whole question of working hours at South Wales docks and report and make recommendations to a future conference.

Tin-plate Depression.

Tin-plate makers in South Wales have decided, in view of the depressed conditions, to restrict output for a period of about six weeks.

Steelworkers' Bonus.

Adult workmen who have hitherto been on a base rate of 30s. per week and under in the West Wales steel industry have been granted a further 10 per cent. on the existing 20 per cent. *ex gratia* bonus at present being paid them under the Conciliation Board arrangement. This comes into operation as from the beginning of this week, and several thousand workmen benefit. A claim for an increase in wages in respect of lower paid men in similar trades in the tin-plate industry is stated to be under discussion.

Current Business.

New business on the coal market has been quiet during the past week, but the tone on the whole is fairly steady, as collieries are pretty well stemmed for prompt shipment. Best Admiralty large coals remain at 27s. to 27s. 6d., with second qualities about 25s. 6d. to 26s. 6d. Dry qualities are somewhat slow in demand, while smalls are irregular. Best descriptions are moving off fairly well, and are steady, but inferior sorts are in good supply. Patent fuel and coke remain unaltered, and pitwood on account of the difficulty in securing wagons continues on the easy side. Anthracite coals barely maintain recent quotations, as, owing to the mild weather prevailing, the demand is not so active.

CALENDARS, DIARIES, &c.

W. JOHNSON, GILL, SEALE AND CO., Limited, 5-6, Great Winchester-street, E.C. 2.—Wall calendar with monthly tear-off shee.s.

ROYCE LIMITED, Trafford Park, Manchester.—Wall calendar with monthly tear-off sheets.

PRIEST FURNACES, Limited, 123, Albert-road, Middlesbrough.—Refills for desk stand calendar.

R. Y. PICKERING AND CO., Limited, Wishaw, Scotland.—Wall calendar with monthly tear-off sheets.

ASHWELL AND NESBIT, Limited, Barkby-lane, Leicester.—Wall calendar with daily tear-off sheets.

LE GRAND, SUTCLIFFE AND GELL, Limited, Southall, London, W.—Wall calendar with daily change cards.

J. SHAW, SON AND GREENHALGH, Limited, Albert Works, Huddersfield.—Wall calendar with monthly tear-off sheets.

VENESTA LIMITED, 1, Great Tower-street, E.C. 3.—Desk calendar made with "Plymax" and daily turn-over sheets.

THE STANLEE SHIPBREAKING AND SALVAGE COMPANY, Limited, Dover.—Desk calendar, daily tear-off sheets and scribbling pad.

LAUNCHES AND TRIAL TRIPS.

QUEDA, steamer; built by Wm. Gray and Co., Limited, to the order of the British India Steam Navigation Company; dimensions, 502ft. by 60ft. 9in. by 32ft. 8in. Engines, balanced quadruple, 28½in., 41in., 58½in. and 85in. by 54in. stroke, pressure 225 lb.; constructed by the builders; trial trip, January 5th and 6th.

HEBBURN, steel screw cargo steamer; built by the Blyth Shipbuilding and Dry Docks Company, Limited; to the order of Huddort, Parker, Limited; dimensions, 383ft. 6in. by 51ft. by 26ft. 9in.; to carry 6500 tons. Engines, triple-expansion, 24in., 39in., 65in. by 45in. stroke; constructed by the North-Eastern Marine Engineering Company; launch, January 8th.

CATHERINE RADCLIFFE, screw steamer; built by Craig, Taylor and Co., Limited; to the order of Evan Thomas Radcliffe and Co.; dimensions, 430ft. by 55ft. 6in. by 30ft. 7½in. Engines, 28in., 46in., 75in. by 48in. stroke, pressure 180 lb.; constructed by Blair and Co., Limited; launch, January 9th.

ALYNBANE, twin-screw motor vessel; built by Harland and Wolff, Limited, to the order of Andrew Weir and Co.; dimensions, 434ft. by 53ft. 9in. by 37ft.; 5200 gross tonnage. Engines, two sets of six-cylinder Diesel; constructed by the builders; launch, January 15th.

SUNFLOWER, steamship; built by Philip and Son, Limited, of Dartmouth, to the order of the Vacuum Oil Company, Limited; dimensions, 200ft. by 37ft. by 15ft.; 850 tons deadweight. Engines, triple-expansion, 15in., 25in. and 46in. with 27in. stroke, pressure 180 lb.; constructed by the builders; trial trip, January 17th.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	17/6 to 24/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 15 0	—
No. 1 Foundry	4 12 6	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 7 0	4 7 0
No. 1	4 7 6	4 7 6
Cleveland—		
No. 1	4 5 0	4 5 0
Silicious Iron	4 5 0	4 5 0
No. 3 G.M.B.	4 0 0	4 0 0
No. 4 Foundry	3 19 0	3 19 0
No. 4 Forge	18 0	3 18 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 16 0 to 3 17 0	
,, Forge	3 11 0 to 3 12 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 17 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	4 0 0	—
Basic	4 5 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 2 6 (a) 5 7 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. COAST—		
Common Bars	12 0 0	—
LANCS.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0 to 13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ¼in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ¼in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	£ s. d.	Export. £ s. d.
N.E. COAST—			
Ship Plates	9 15 0	.. ..	—
Angles	9 10 0	.. ..	—
Boiler Plates	13 0 0	.. ..	—
Joists	9 10 0	.. ..	—
Heavy Rails	9 0 0	.. ..	—
Fish-plates	13 0 0	.. ..	—
Channels	10 5 0	.. ..	£9 to £9 5
Hard Billets	9 10 0	.. ..	—
Soft Billets	8 10 0	.. ..	—
N.W. COAST—			
BARROW—			
Heavy Rails	9 0 0†	.. ..	—
Light ,,	9 5 0	to 9 10 0	
Billets	8 0 0	to 11 10 0†	
MANCHESTER—			
Bars (Round)	10 0 0	to 10 10 0	
,, (others)	9 15 0	to 10 0 0	
Hoops (Best)	15 5 0	.. ..	15 0 0
,, (Soft Steel)	13 15 0	.. ..	13 10 0
Plates	9 15 0	to 10 0 0	
,, (Lancs. Boiler)	13 0 0	.. ..	—
SHEFFIELD—			
Siemens Acid Billets	11 10 0	.. ..	—
Bessemer Billets	13 0 0	.. ..	—
Hard Basic	9 10 0	.. ..	—
Intermediate Basic	9 0 0	.. ..	—
Soft Basic	8 0 0	to 8 5 0	
Hoops	12 0 0	.. ..	—
Soft Wire Rods	11 0 0	to 11 10 0	
MIDLANDS—			
Small Rolled Bars	9 0 0	to 9 15 0	
Billets and Sheet-bars	7 2 6	to 7 10 0	
Sheets (20 W.G.)	11 10 0	to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 2 6	to 17 5 0	
Angles	9 5 0	.. ..	—
Joists	9 5 0	.. ..	—
Tees	10 5 0	.. ..	—
Bridge and Tank Plates	9 15 0	.. ..	—
Boiler Plates	13 10 0	.. ..	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	259 0 0
,, (three months)	263 0 0
Copper (cash)	65 5 0
,, (three months)	66 5 0
Spanish Lead (cash)	41 10 0
,, (three months)	39 10 0
Spelter (cash)	38 0 0
,, (three months)	37 7 6
MANCHESTER—	
Copper, Best Selected Ingots	72 0 0
,, Electrolytic	72 10 0
,, Strong Sheets	96 0 0
,, Tubes (Basis Price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
,, Condenser	0 1 2½
Lead, English	44 1 0
,, Foreign	43 0 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 10 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	16/-
,, ,, 1 p.c. ,,	£52 0 0	17/6
,, ,, 0.75 p.c. carbon	£60 0 0	20/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£17 17 6 scale 6/- per unit	
,, Vanadium	17/6 per lb.	
,, Molybdenum	7/9 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£165	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	16/9
,, ,, Ell	18/4½
,, ,, Splint	18/6 to 22/9
,, ,, Trebles	18/1
,, ,, Doubles	17/9
,, ,, Singles	14/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
,, ,, Splints	18/6
,, ,, Trebles	18/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	14/10½ to 17/1½
Screened Navigation	24/-
Trebles	19/- to 20/-
Doubles	17/9
Singles	14/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	16/6
Secondary Steam	15/9
Trebles	19/3
Doubles	18/-
Singles	14/3

ENGLAND.

(8) N.W. COAST—	
Steams	28/6
Household	45/- to 58/4
Coke	30/-
NORTHUMBERLAND—	Inland.
Best Steams	18/6
Second Steams	17/6 to 18/-
Steam Smalls	10/6
Unscreened	15/6 to 17/-
Household	23/6 to 25/-
DURHAM—	
Best Gas	21/6
Second	18/- to 18/6
Household	23/6 to 25/-
Foundry Coke	24/- to 24/3
SHEFFIELD—	Inland.
Best Hand-picked Branch	30/- to 33/-
Barnsley Best Silkstone	26/- to 28/-
Derbyshire Best Brights	26/- to 31/- —
,, ,, House	24/- to 26/- —
,, ,, Large Nuts	22/6 to 25/- —
,, ,, Small	14/- to 16/- —
Yorkshire Hards	19/6 to 23/- —
Derbyshire ,,	19/6 to 22/- —
Rough Slacks	9/6 to 12/- —
Nutty ,,	8/6 to 10/6 —
Smalls	4/- to 6/6 —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 21/6 to 22/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	27/- to 27/6
Second ,, ,,	26/- to 27/-
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	24/- to 25/-
Best Black Vein Large	24/6 to 25/-
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/6 to 24/6
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	16/- to 16/6
Ordinary ,,	13/- to 15/-
Washed Nuts	22/- to 32/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	22/6 to 23/6
,, ,, Through	18/- to 20/-
,, ,, Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	27/6 to 32/6
Patent Fuel	25/- to 27/-
Pitwood (ex ship)	24/6 to 25/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	45/- to 47/6
Seconds	36/6 to 37/6
Red Vein	32/6 to 35/-
Machine-made Cobbles	50/- to 55/-
Nuts	55/- to 57/6
Beans	44/- to 45/-
Peas	20/- to 23/-
Breaker Duff	9/- to 9/6
Rubbly Culm	10/- to 10/6
Steam Coals :	
Large	24/6 to 25/6
Seconds	22/6 to 24/6
Smalls	14/- to 16/-
Cargo Through	17/- to 19/-

(1) Delivered. (2) Not Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated.

coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis; open market, round about 22/6 to 25/- at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Exhibition Palace.

THE buildings which are being erected at the Porte de Versailles for the holding of exhibitions are still in a very backward condition, owing partly to strikes; but the Exhibition Palace was, in a sense, inaugurated last week when the annual agricultural machinery show was held in a vast building that was rapidly completed for the purpose. This construction, which consists of a large number of bays, was much more suited for a show of this kind than the more palatial Grand Palais where the Salon de la Machine Agricole was held in previous years. Although it has been possible to hold this first show in what is probably destined to be a machinery hall, it is not likely that the other buildings will be completed for some months to come; but from what can be seen of them, it is certain that the Exhibition Palace will be worthy of the object for which it is intended. Its architectural features are pleasing, and the construction is particularly bold, with huge concrete arches springing up from the ground to the roof. Concrete is employed throughout. The palace is being constructed by a private company, which has obtained certain concessions from the Paris Municipal Council, notably an undertaking that all future exhibitions—apart, of course, from those having an international character—shall be held in the new buildings.

Liquid Fuels.

The interest attached to liquid fuels is observable in the further re-organisation of the various committees and other bodies appointed to deal with the problem. The Comité Scientifique du Pétrole has created a new section which will investigate all matters relating to the production of motor fuels and lubricants from vegetable oils. M. Daniel Berthelot is President of this section, and amongst the distinguished members is M. Sabatier, whose name is closely identified with the catalytic production of petrol. A further impulse is also to be given to alcohol investigation. The object of these bodies is to obtain from colonial vegetable products a motor fuel that will replace imported petrol. Another new creation is the Office National des Combustibles Liquides, which is an autonomous public body that will grant licences for the importation of oils in bulk under certain conditions, such as the necessity of constituting stocks and of giving to the State a priority of supplies. It will also regulate prices, collect information and data of interest to the oil industry, and will encourage research work in the discovery of new fuels. The Office will impose a contribution of 10f. per ton of oil going into consumption, and for a period of ten years, one-half of the revenue derived from this source will be distributed as subsidies for tank steamers.

"Makhonine Liquid."

So much secrecy has been observed over the new process for producing a motor fuel direct from any kind of crude oil, invented by a Russian engineer, M. Makhonine, and experimented with under the supervision of military experts at Vincennes, that some scepticism has been expressed regarding the value of the process, despite the extraordinary results claimed to have been obtained. The inventor has made a free gift to the nation of the right to employ his process for military purposes, and official statements have been made with the idea, apparently, of impressing upon the public the foresight of the present Government in providing M. Makhonine with the means of carrying out tests, after he had been ignored by its predecessors. It is therefore suggested that a certain political bias has been introduced into a controversy which leaves the public mind very unsettled as to the value of the system. Many scientists and experts are by no means satisfied that the invention is of as much value as it is represented to be. Nevertheless, others who have witnessed the tests declare that it solves completely the problem of cheap motor fuels. Described as the "Makhonine liquid," the fuel lacks stability, as it is said to return to its original physical condition after a certain time. It must be used within a period of a few weeks, and preferably it is produced on the vehicle itself. The idea of the inventor is to simplify the apparatus so that it can be employed on all kinds of heavy vehicles, and even on locomotives. The Government official who has been extolling the merits of the invention declares that in view of the great economy effected by the use of the "Makhonine liquid," instructions have been given to the railway companies to place no more orders for electric locomotives, for which may be substituted locomotives running on the new liquid fuel, but no one has been able to obtain confirmation that the companies have received such instructions.

A New Locomotive.

The locomotive shops of the Est Railway Company have recently delivered the first of a new type of locomotive with eight driving wheels and front bogie, for service on the Paris–Strasburg line. The engine weighs more than 100 tons, and its length is 52ft. 6in., while the total weight, with coal and water, is 185 tons. The object in building this locomotive is to haul heavy trains at the maximum speed of 69 miles an hour permissible in the actual state of the permanent way. Some preliminary runs between Epernay and Châlons were satisfactory, and the machine was returned to the shop to be painted, after which it will be put to extended trials.

Incinerators.

The Paris Municipal Council is embarrassed because the incineration of household refuse is regarded by those living near the destructor station as a public nuisance. The proposal to install an incineration plant at Meudon has resulted in the Municipal Council of that suburban town resigning in a body. There is, it may be remarked, the same objection at Marseilles, where the refuse is to be dealt with in a similar manner.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

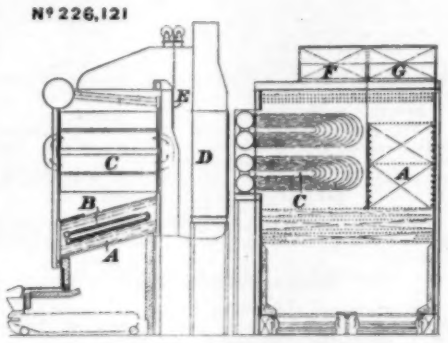
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

226,121. July 12th, 1924.—WATER-TUBE BOILERS, Babcock and Wilcox, Limited, and Sir J. Kemnal, Babcock House, Farringdon-street, London, E.C. 4.

This invention provides an arrangement by means of which the gases may be caused to pass either from the furnace and through part of the generator and superheater to the reheater and thence to the air heater, or through part of the generator and superheater to the air heater, or through the whole of the generator and superheater and reheater to the air heater. This result is attained by providing at the top of the boiler casing two inter-

Nº 226,121



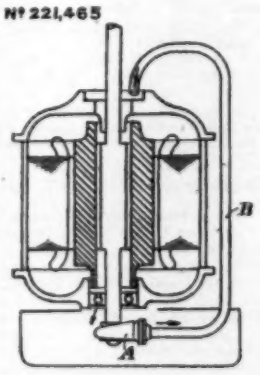
connected dampers, one for controlling the flue leading from the reheater and the other controlling a flue isolated from the reheater, the dampers being arranged in such manner that when one is moved into the open position the other moves into the closed position, or the dampers may both be partly open so that the gases pass over the whole surface of the generator, superheater and reheater and thence to the air heater. In the drawing A is the generator, B the superheater, C the reheater, and D the air heater. One of the dampers is shown at E, and the pair of them control the two flues F and G.—*December 18th*, 1924.

DYNAMOS AND MOTORS.

221,465. January 5th, 1924.—LUBRICATING DEVICE FOR VERTICAL ELECTRIC MOTORS, Rento Walter Hendrick Hofstede Crull, of Doetinchem, The Netherlands.

The method of lubricating a vertical electric motor in accordance with this invention will readily be understood from the

Nº 221,465



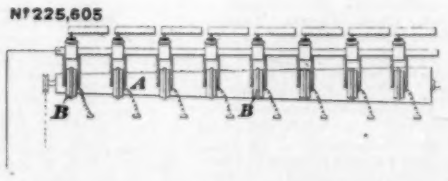
accompanying drawing. The lubricating oil is pumped by means of one or more pumps A to the upper bearing of the machine through a passage B, and it then flows downwards to the lower bearing through one or more passages in the rotor. Preferably these passages are helically shaped.—*December 18th*, 1924.

TELEGRAPHS AND TELEPHONES.

225,605. August 30th, 1923.—IMPROVEMENTS IN OR RELATING TO SYSTEMS FOR VARYING ELECTRICAL FREQUENCIES, Manrico Compare, of 8, Oxford-terrace, Hyde Park, London, W. 2, and Thornely Carbutt Gibson, of 142, Wool-exchange, Coleman-street, E.C. 2.

The apparatus described in this specification consists broadly

Nº 225,605



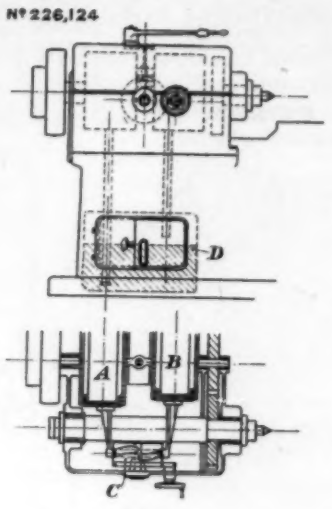
of a revolving cone A, which is arranged to drive generators B, which can be adjusted lengthways on the cone. The apparatus, the inventors explain, is applicable to various electrical processes, and may be employed with advantage in certain selective wireless transmitting systems.—*May 21st*, 1924.

TRANSMISSION OF POWER.

226,124. February 19th, 1924.—VARIABLE SPEED GEARS, H. Thoma, 22, Lachnerstrasse, Münich, Germany.

In this hydraulic gear the inventor varies the speed by altering the throw of the pump A and also that of the motor B. The alteration is not, however, made simultaneously. On a drum C there are two cam slots in which rollers work to regulate the

Nº 226,124



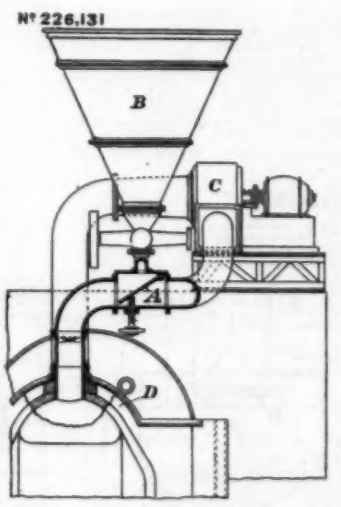
throw of the pump and motor. The shape of these slots is such that when the drum is rotated the pump is first brought up to full delivery, and then its roller rides in a straight part of the cam slot. Further rotation of the drum then regulates the throw of the motor. A reservoir for the fluid used in the machines is shown at D.—*December 18th*, 1924.

FURNACES.

226,131. August 28th, 1924.—POWDERED FUEL FURNACES, C. Hold, Konigstrasse 84, Carnap, near Essen, Germany.

The inventor states that it is undesirable to inject powdered fuel into a furnace by means of a high-pressure air jet, as it tends to project some of the coal straight through the furnace, without it being burned. He thus provides a throttling valve A

Nº 226,131



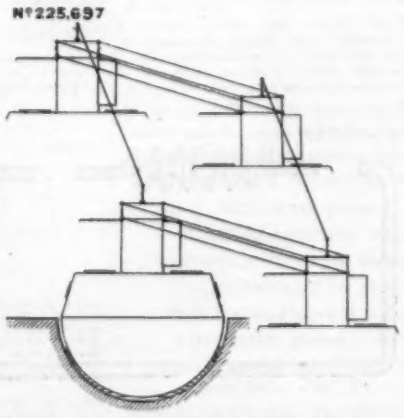
in the air supply pipe, at the point where the coal is fed in from the hopper B. In this way, he claims, a partial vacuum of, say, 2 mm. to 3 mm. water gauge is created behind the valve, and, as a consequence, the mixture of air and coal dust flows through the combusion zone in the most favourable direction. C is a fan for supplying the air, which is preheated in the space D round the furnace.—*December 18th*, 1924.

SHIPS AND BOATS.

225,697. November 20th, 1923.—FLOATING PLATFORMS, L. T. Couty, 10, Quai de la République Tulle, France.

The inventor proposes to mount a series of hemispherical

Nº 225,697



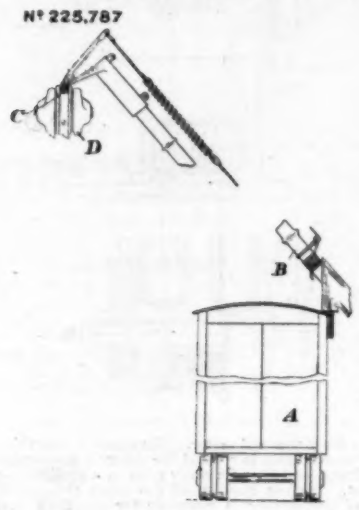
floats in cup-shaped hollows on the deck of a ship, so that they may float off, in case of wreck, and thus form life-saving rafts. Incidentally the floats would remain more or less level as the

ship rolled. He also connects all the floats together by means of the linkwork shown, in order that they may move in unison.—*December 11th*, 1924.

TRAMWAYS AND RAILWAYS.

225,787. July 2nd, 1924.—IMPROVEMENTS IN OR RELATING TO COLLECTORS FOR OVERHEAD ELECTRIC LINES, Thomas Brook, The Woods Gilbert Rail Remodelling Company, Limited, of 170, Strand, W.C. 2.

The object of this invention is to provide an arrangement for tapping an overhead electric line for working roadside plant without otherwise interfering with the line. In the drawing A

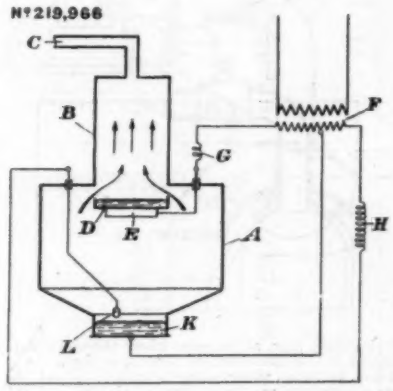


is a roadside repair truck with a collector arm B, which collects current from a trolley wire C, D being the upper part of an ordinary trolley pole of a tramcar or other electric vehicle. By means of a special gripping device, which is fully described in the specification, the repair truck A can draw its current from the upper part of the wire without interfering with the normal service of the wire C.—*December 11th*, 1924.

MISCELLANEOUS.

219,966. July 30th, 1923.—IMPROVEMENTS IN AND RELATING TO DEVICES FOR HEATING THE INTERNAL MERCURY VAPOUR HIGH VACUUM PUMP OF A RECTIFIER, Brown, Boveri et Cie., Baden, Switzerland.

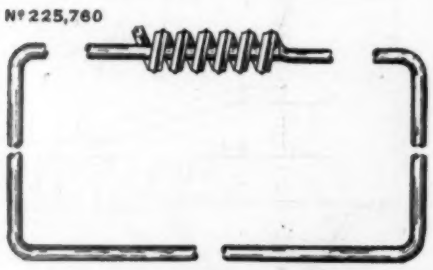
According to this invention the cooling dome B of the rectifier A is provided with a connection C for the preliminary vacuum pump and serves at the same time as a condensing chamber for the mercury of the high vacuum pump which is in the vessel D. The latter is heated by means of the exciting anode E, which is in the form of a plate. In order to enable more energy to be



liberated at this heating anode than at the other exciting anodes, which are not shown, the secondary side of the exciting transformer F is made asymmetrical. Moreover, the phase voltage in the heating anode phase is greater than in the other exciting phases. Resistances and reactances G and H are inserted between the exciting transformer F and the anodes. The neutral point of the exciting transformer F is directly connected to the cathode K. Several exciting anodes may be used to heat the high vacuum pump. The ignition anode is shown at L.—*December 11th*, 1924.

225,760. March 26th, 1924.—BALING STRAPS, E. A. Power, Adderley road, Saltley, Birmingham.

This wire strap for bales or packing cases has one of its ends coiled into a helix as shown. This end of the wire is previously drawn through a die plate to form a series of longitudinal grooves



and ridges on its surface. The strap is put round the bale, its free end threaded into the helix and the helix is then crushed in any convenient manner so that its ridges are made to bite into the end of the wire and hold it securely.—*December 11th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Reports to the Cutting Tools Research Committee: "Flow and Rupture of Metals during Cutting," by Dr. W. Rosenhain and Mr. A. C. Sturney; and "An Experimental Study of the Forces Exerted on the Surface of a Cutting Tool," by Dr. T. E. Stanton and Mr. J. H. Hyde. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Boiler-house Records and their Practical Value," by Mr. R. H. Parsons. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Lecture Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne. Lecture on "Railway Electrification in Switzerland," by Mr. E. A. Eborall. 7.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, London, S.W. 7. Papers, "An Investigation into Corrections Involved in the Measurement of Small Differences in Refractive Index of Dispersive Media by means of the Rayleigh Interferometer, with Special Reference to the Application of the Results to Measurements in Diffusion," by Mr. B. W. Clack; and "A Study of the Production of Flashing in Air Electric Discharge Tubes," by Messrs. J. Taylor and W. Clarkson. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Science and the Cotton Industry," by Dr. A. W. Crossley. 9 p.m.

SATURDAY, JANUARY 24TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—London Graduates' visit to the works of A.C. Cars, Limited, Thames Ditton. 2.30 p.m.

MONDAY, JANUARY 26TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, London, S.W. 1. Graduates' cinema evening. 7.30 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, London, E.C. 1. "The Properties and Uses of Monel Metal," by Mr. C. A. Packer. 5.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Radiological Research—A History," by Mr. V. E. Pullin. 8 p.m.

UNIVERSITY COLLEGE, LONDON, ENGINEERING SOCIETY.—University College, London. Annual dinner.

TUESDAY, JANUARY 27TH.

ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Discussion on "The Effect of Internal Obstructions on the Performance of a Lighting System," opened by Mr. J. W. T. Walsh. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1. Paper, "A Review of the Rating Question," by Mr. A. E. Berriman. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Broadgate Café, Coventry. Graduates' meeting. Paper, "Gearing," by Mr. L. Jefferies. 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Papers: "The Southampton Floating Dock," by Dr. E. H. Salmon; and "Southampton Floating Dock: Subsidiary Works," by Mr. F. E. Wentworth-Sheilds. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Great Hall, The University, Leeds. Faraday Lecture, "World-wide Radio Telegraphy," by Professor G. W. O. Howe. 7.30 p.m

WEDNESDAY, JANUARY 28TH.

ENGINEERS' CLUB.—Manchester. Dinner to the Lord Mayor of Manchester (Alderman F. J. West), Sir Benjamin Longbottom and others. 6.45 for 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Birmingham Graduates' visit to the works of British Timken, Limited, Ward End. 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Milton Hall, 244, Deansgate, Manchester. Paper, "The Respective Spheres of Petrol, Steam and Electric Commercial Vehicles," by Mr. W. D. Williamson. 6.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1. Paper, "Studies in Filtration," by Messrs. B. W. Clarke, S. G. M. Ure, and J. W. Hinchley. 8 p.m.

NEWCOMEN SOCIETY.—Prince Henry's Room, Fleet-street, London, E.C. 4. Papers, "Windmills of Cape Cod," by Mr. E. P. Hamilton; "Lighting by Coal Gas in 1765," by Mr. J. Macfarlan; and "Some Notes on a Neglected Worthy, John Patison of Airdrie," by Mr. D. Brownlie. 5.30 p.m.

ROYAL MICROSCOPICAL SOCIETY.—20, Hanover-square, London, W. 1. Discussion, "The Use of the Microscope in the Dairying Industry. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Electrical Equipment of the London County Hall," by Mr. C. A. Baker. 8 p.m.

THURSDAY, JANUARY 29TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. "Railway Carriage Bogie Trucks in Service," by Mr. H. Kelway-Bamber. 7 p.m.

INSTITUTION OF WELDING ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Paper, "The Philosophy of Welding," by Sir W. Peter Rylands. 8 p.m.

LIVERPOOL ENGINEERING SOCIETY.—Midland Adelphi Hotel, Liverpool. Annual dinner. 7 for 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Lecture, "The Properties and Structure of Quartz," by Sir William Bragg. 5.15 p.m.

FRIDAY, JANUARY 30TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Informal discussion on "Alternatives to the 'Clash' Type of Change-speed Gear for Motor Vehicles." 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Notes on High Voltage Electrical Transmission," by Mr. E. Ambrose. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Mountain Structure and Geographical Relations of South-Eastern Asia," by Professor John W. Gregory. 9 p.m.

SATURDAY, JANUARY 31ST.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Guildhall, York. Quarterly meeting of the Yorkshire District. 2.30 p.m.

WOMEN'S ENGINEERING SOCIETY.—Visit of the London Branch to the Hackney Power Station and Sub-stations. 2.30 p.m.

MONDAY, FEBRUARY 2ND.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-WESTERN SECTION.—Manchester Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. Lecture, "The Design and Construction of a Piano Player," by Mr. G. B. Walker. 7.15 p.m.

SOCIETY OF ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Presidential address, by Mr. A. Stewart Buckle. 5.30 p.m.

TUESDAY FEBRUARY 3RD.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, London, E. 1. "The Treatment of Boiler Feed Water," by Messrs. W. B. Lewis and G. S. Irving. 6.30 p.m.

WENESDAY, FEBRUARY 4TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to Neasden Carriage and Wagon Works, Metropolitan Railway.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless section meeting. "The Optimum Damping in the Auditive Reception of Wireless Telegraph Signals," by Messrs. L. B. Turner and F. P. Best. 6 p.m.

THURSDAY, FEBRUARY 5TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Queen's Hotel, Birmingham. Annual dinner. 6.30 for 7 p.m.

FRIDAY, FEBRUARY 6TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. "Anti-friction Bearing Applications for Heavy Duty," by Mr. J. B. Dahlerus. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "The Measurement of Hardness and Allied Properties of Metals," by Mr. E. G. Herbert. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. H. W. FAIRMAN, F.I.S.A., secretary of Faraday House Electrical Engineering College, has been appointed to the Council of the Secretaries Association.

WE are informed that Mr. G. A. Hughes, A.M. I. Mech. E., has been appointed a director of Le Grand, Sutcliff and Gell, Limited, artesian well engineers, Southall.

AT a meeting of the Council of the Institution of Civil Engineers, held on January 13th, Senatore G. Marconi, G.C.V.O., LL.D., was unanimously elected an honorary member of the Institution.

WE are requested to announce that at the recent annual meeting of Wailes Dove Bitumastic, Limited, Mr. E. J. Dove resigned his position of managing director and Mr. Charles Macdonald resigned his position as assistant managing director. The services of both as directors of the company are still being retained. Mr. W. H. Dick, who has been for some years assistant managing director, was appointed managing director of the company.

RADIO INSTRUMENTS, Limited, of 12, Hyde-street, New Oxford-street, London, W.C. 1, informs us that it has just appointed new representatives in the Northern districts as follows:—For Manchester and district, the Manchester Radio Company, Limited, 155, Oxford-road, Manchester; for the Liverpool district and North Wales, the B.N.B. Wireless, Limited, 65, Renshaw-street, Liverpool; for the Bradford district and the northern district of Yorkshire, Frank Riddiough and Sons, Westgate, Bradford; and for the Sheffield district and South Yorkshire, also North Lincolnshire, C. E. Needham Bros. and Sons, Change-alley, Sheffield.

CONTRACTS.

FRANK HOW AND CO. have again been given a large order by the Air Ministry for the supply of aero-engine oil.

JOSEPH KAYE AND SONS, Limited, of Lock Works, Leeds, have recently received orders for the supply of a large quantity of their seamless steel oil-feeders from the London and North-Eastern Railway.

THE VICKERS-SPEARING BOILER COMPANY, Limited, Bank-buildings, 20, Kingsway, W.C. 2, has received an order from the West Midland Sugar Company, through the main contractors, Duncan Stuart, Limited, Glasgow, for four 15,000 lb. cross type water-tube boilers fitted with Illinois chain-grate stokers, for the new Sugar Beet Factory at Kidderminster.

LOCOMOTIVES—CLUJ.—His Majesty's Consul at Cluj reports that a firm has approached him asking to be furnished with quotations for a locomotive of about 70 horse-power. Further particulars regarding this inquiry can be obtained on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1, quoting reference A.X. 1654.

SOUTH AFRICAN IRRIGATION.—It is much to be regretted that the publication of that very interesting quarterly, the *Magazine* of the South African Irrigation Department, was brought to a close with the December issue of last year. The editor expresses the hope that it will not be long before the *Magazine* is revived, a hope which all irrigation engineers will share, as it deals very usefully with a wide range of subjects included under irrigation engineering, as well as with agricultural matters relating to irrigation. It is interesting to note, further, from the December editorial columns that an important development may possibly take place in South Africa. "Should a body be created which will be organised to deal with the agricultural, settlement and financial sides as well as the engineering side of irrigation, it will be a simple matter to arrange for helpful articles to be supplied to the *Magazine* on each of these features. . . ."